JPRS: 4772

12 July 1961

AUTOMATION AND SOCIETY

by Jan Auerhan

-USSR-

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JPRS: 4772

CSO: 1767-S

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[Following is the translation of the book Avtomatizatsiya i obshchestvo (English version above) by Jan Auerhan; Socio-Economic Publishing House, Moscow, 1960, pages 1-169.]

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Chapter I

AUTOMATION, A NEW STEP IN THE DEVELOPMENT OF PRODUCTIVITY OF COMMUNAL WORK

(A Technical-Economic Characterization of Automation)

1. The Place of Automation in the Development of Technology

During the recent years the term "automation" is used more and more often in the economic, technical, philosophic, and other literature of many countries. However, on closer examination it becomes clear that this term is understood differently by different authors. There exists a great number of opinions which can be judged only when the principal subject of discussion has been defined. This subject is formulated in approximately the following form: What is the place of automation in the development of technology, is it an independent, qualitatively new stage of this development? If the answer is affirmative, then what is the substance of automation? How does it differ from the preceding stage of technical development?

The British bourgeois economist Paul Einstig considers automation to be simply the "synonym of progressive mechanization." The American senator O'Mahony goes still further and asserts that automation is only a new word for "the problem which arose simultaneously with the first lathe or even with the first wheel." Thus the proponents of this concept which is prevalent in bourgeois literature deny any specific quality of automation as a new, qualitatively different stage of technical development.

Other authors take the opposite stand. For example, a West-German reformist theoretician Carlo Schmidt asserts that "the automation of many industrial processes and the electronic brain are phenomena which cannot be compared with anything in our industrial relations" and that this new technology "appears spontaneously without any continuous ties to the past events."

Let us, for the time being, set aside the fact that both these concepts in most instances are not the result of a materially disinterested scientific investigation. At present we are only interested in the manner in which they solve the problem of the place of automation in the development of technology. Thus, we are discussing two extreme opinions the first of which denied the definition of automation as a new independent phase of technical development and emphasizes its relationship with the preceding development of technology, whereas the second one maintains a diametrically opposed point of view. The common basis of these extreme polar opinions is the metaphysical approach to the study of the problem, the one-sided emphasis on and separation from the mutual relationship of the phenomena characteristic of both sides of the objective reality.

A scientific definition of the place of automation in the development of technology cannot refrain from taking into account, on the one hand, the inseparable bond connecting automation with the entire history of the gradual strengthening and extension of the power of man over the forces of nature, and on the other, the qualitatively novel features which distinguish automation from the preceding stages of technological development. Automation is the continuation and natural result of the technological development representing, however, a qualitatively new stage, a veritable leap in the development of the productive forces. This is the solution of this problem by the Marxist science and this solution is the only scientific determination of the place of automation in the development of technology.

Automation is the logical result and continuation of technological development. Its feasibility and indispensability are determined by the process of the development of material production. The conversion to mass production in many branches of industry, the complex mechanization of the industrial processes, invention of control devices, a more profound comprehension and mastering of the technical laws governing the industrial process, the rapid development of electronics and communication technique, in brief, the entire preceding progress of technology created a technological feasibility of the automation of industrial processes.

Further development of technology requires the conversion to automation more and more. The majority of the industrial processes at the present time has become so complicated and the requirements for maintaining the conditions of work have risen so high, that even now man cannot always watch the numerous instruments, direct the process, and take timely measures which ensure its normal course.

Automation is the continuation and natural result of technical development, but it does not represent a higher stage of mechanization only. The distinctive feature of automation consists of the fact that the industrial process is accomplished without the participation of man. Mechanical devices perform the functions of directing and controling this process.

Under the conditions of mechanization the machine replaces man's physical labor, but man must still control its operations in detail and direct them. Man must constantly watch over the work of the machine and direct its activity. Automation removes the necessity for such a type of control, inasmuch as the machine regulates its own work according to a prescribed program. Man must only prescribe this program, see to it that the machine is in order, and interfere with the process of the work only in exceptional instances when owing to some unforeseen circumstance the machine should deviate from the prescribed program. Thus, in automation the machine fulfills certain functions of the managing work of man in industry. Therefore, the conversion to automation completes the liberation of man from the immediate participation in the industrial process and changes abruptly the entire character of human labor. Up to now the machine replaced the hands and the muscles of man; at present it begins to replace, within certain limits, his brain and nervous system.

The number of tools which the human artisan can use simultaneously, the power, speed, and precision of this operation are limited by the number and capabilities of the organs of the human body. Mechanization does away with these limitations by transferring the tools from man to the machine. "Thus the number of implements used simultaneously by the same machine is from the very beginning emancipated from the organic limitations to which the hand tool of the worker is subjected."1 /See Note/

(/Note/ K. Marx, Kapital /Capital/, Vol I, Gospolitizdat, 1955, page 380.)

However, in many instances mechanization still retains the necessity for heavy physical labor (loading of a machine, transfer of the semi-product from one machine to the other, etc.) and primarily the necessity of constant control by man over the work of the mechanism. Mechanization does not entirely abolish these types of work. The number of mechanisms, the rate of the flow of the industrial process which the worker is able to control, the speed and precision of his interference with the work of the mechanism are in the long run limited by the capabilities of the human nervous system. Consequently, mechanization, even in its highest phase of complex mechanization, does not entirely eliminate the subjective principle of the division of labor typical in manufacture, i.e., the adaptation of the industrial process to the worker.

Automation successively liquidates the dependence of the industrial process on the physical capabilities of man. A mechanism can control the industrial process and direct it better than man, without fatigue, and with far greater precision, speed, and correctness. It can work under conditions which are unbearable for the human organism, under high or extra low pressures and temperatures, under dangerous conditions, etc. This makes it possible to perform operations which surpass the possibilities of manual operation of the machine and visual control. Therefore automation affords objective division of the industrial process according to its own character and ensures the creation of industrial technology which is independent of the capabilities of the worker serving it, and is based exclusively on scientific knowledge and technical mastering of the laws governing the industrial process.

The modern supermechanized factory in most instances represents a technological unity in the sense that many industrial machines concentrated in one place are simultaneously and regularly set in motion by a common motor mechanism and are connected into a single entity by a system of transmissions. But the industrial process as such in the absolute majority of instances does not represent such a technical entity. It is divided into a series of independent processes related neither by the flow of intermediate product from one division to the other nor by the industrial rhythm. This is characteristic of some industries to a greater degree (for example, machine building or metallurgy) and of others to a lesser degree (for example, certain chemical industries) but whether to the one or the other extent, this feature is present in the great majority of non-automated industries. The unity of the industrial process, therefore, exists rather subjectively in the plans of the management and in the

prescribed production programs. Automation puts this unity into reality objectively, as a technical unity of the entire industrial process: Instead of individual machines arranged in groups according to the types of the equipment there appears an integrated system of machines, mutually connected into a single, rhythmically operating unity which controls and regulates its own operations and corrects deviations from the prescribed program and in which the raw material or the intermediate product moves through the individual operations without the employment of human hands and without the immediate participation of man in the industrial process in general.

Whereas up to the present time the development of the machine industry was principally characterized by the gradual division of the industrial process into simple operations performed by individual highly specialized machines, automation, to the contrary, represents the opposite tendency, one of combining all the operations necessary for the manufacturing of the product, (or at least of a group of these operations) on a single assembly or a single system of machines mutually combined into a single entity.

The boundary between mechanization and automation cannot be drawn with absolute accuracy. This division includes only the larger, general characteristic features, since the epochs in the history of industrial implements are not separated from one another by strictly delineated boundaries. From its very inception mechanization brought along with it certain elements of automation and individual examples of automatic control of the work of a mechanism have been known for a long time. Thus Jacquard's loom shown to the public for the first time in 1801 was operated automatically by means of a perforated paper card; Watt's steam engine invented at the end of the 18th century had an automatic centrifugal regulator. More and more individual elements of automatic control appear in machines of the 19th and 20th centuries.

Even before the Second World War individual industrial establishments have introduced automatic regulation and control of certain parameters of chemical processes, automatic regulation of boiler feeding and of the process of combustion in thermal power stations, automatic control of temperature and pressure in the oil refining industry, automatic control of certain equipment of hydraulic power stations, etc. Nevertheless, up to the more recent times innovations in industrial technology exhibited a casual character, while the automatic devices were capable of performing only a very limited number of relatively uncomplicated functions. Only the scientific and technological discoveries, especially in the sphere of electronics and communication technology made during the Second World War and thereafter, afforded the realization of an extensive application of automation along with the further development of complex mechanization and the creation of advanced technology of individual industrial processes. A new branch of technical sciences called automation laid a single theoretical basis for the creation of automatic systems of direction and control which are capable of performing the widest variety of functions that are often exceedingly complex.

All these changes in industry created scientific and technological possibilities for an extensive conversion to automation in a wide variety of branches of industry, for the transition from individual isolated elements of automation to an automated system of machinery. Quantity is converted into quality. Thus, automation prepared by the sum total of the preceding development of technology represents a revolutionary leap in the development of the industrial forces of society, a qualitatively new step of technical development, a new phase in the lengthy process of strengthening and widening the power of man over the forces of nature.

Under the modern conditions automation is the decisive link in the chain of technical progress, the principal trend in the development of technology. The level of automation becomes now the principal index of the degree of technical development of a state.

Automation opens new vistas for the solution of the technical problems in their essence. At the same time in contrast to most of the other forms of technical development which have a specific significance for individual definite branches (development of metalworking, chemical instruments, etc.) automation provides a new concept in the entire industrial process, potentially applicable to the great majority of the branches of industry and in the future, without doubt, to all branches of industry in general.

Automation makes it possible to find the formerly inaccessible solutions and at the same time is in need of such solutions. It is impossible to automate an industrial process based on obsolete and imperfect technology, however, in its turn, the use of new, highly productive, highly intensified technological processes would be impossible without a certain degree of automatic control and direction. For example, the achieved conversion to high pressures and elevated temperature of steam in thermal power stations, as well as a number of new technological processes in the chemical and oil refining industry would be impossible without automation. Modern technology and its development find themselves in ever greater technological conflict with the semi-production conception of the industrial process adapted to the physical capabilities of the workers.

In popular scientific literature, newspaper articles and fiction dealing with automation attention is frequently concentrated on its individual achievements. For example, such literature describes highly-specialized automatic lines in mass production, which increase labor productivity many times, or electronic calculators capable of "remembering" a great amount of data, performing calculations at a rate of several thousand, even tens of thousands operations per second, solving certain problems of logic, "selecting" independently the optimum version of an industrial process, etc. These achievements of modern technology, without any doubt, point to the great possibilities offered by automation even in the contemporary, initial stage of its development; however, it must be borne in mind that they do not fully reflect the true essence of automation and in any case do not exhaust the great variety of processes included in the domain of automation.

Automation covers a great number of processes of technical development which follow three principal trends:

1. Joining separate machine operations into lines or assemblies of continuous production in which feeding of the material, separate operations, and the entire course of the industrial process are generally performed in a prescribed order without human participation, i.e., all these processes are automatic.

2. Control and regulation of the industrial process with the aid of automatic devices and mechanisms which equalize the method by which the operation is performed with the method by which it should be performed. As a result, all deviations in the work of the mechanism are corrected without human interference, automatically.

3. The use of controlling electronic computors which rapidly and automatically note, retain, and process data on the course and conditions of the industrial process, select the optimum program of operation on the basis of the results, and issue orders for the operations of the automatic systems of the machines.[2] /See Note/

(/Note/ Here, incidentally, we must make a remark. Since the practically essential problems of automation differ greatly in the individual branches of industry depending upon actual conditions, certain authors using the experience of their specialized profession identify automation unilaterally with only one of the three groups adduced above. For example, Harder defines automation only as the achievement of the automatic work cycle of the system of the machines. Peacock and a number of other authors understand automation only as automatic regulation; lastly Pike identifies automation with the employment of electronic computers. This limited explanation of automation can be justified to a certain extent if we regard it as the expression of pressing problems of automation in individual branches of industry; however, it impedes the correct appraisal of the place and significance of automation in the development of technology.)

Incorporation of these three principal trends produces an automatic factory, an automatic plant. In such an establishment selection and maintenance of the most advantageous version of the industrial process, principal and auxiliary operations, movement of materials and intermediate products, assembly and control, all these processes are performed without the direct participation of man.[3] /See Note/ Such an automatic factory does not exist yet. However, there are many automatic assemblies, production lines, shops, sections of plants, and entire factories in various branches of industry, which approach the concept of the automatic plant to a greater or lesser degree.

(/Note/ The world literature contains many attempts at characterization of the future automatic plant and fundamentally they differ from one another only by a greater or lesser weight of one or the other trend of the development of automation. In this respect the laurels are won without doubt by Sir Puki who defined an automatic factory as "one in which automation is applied everywhere and where everything is performed automatically." Nothing can be said against such entirely indisputable definition except that it is a common tautology.

As it was said earlier, the term "automation" is not identical to the term "automatic factory." The automatic factory is, of course, the goal of automation, but automation also includes the gradual approach to the automatic factory, the gradual and partial solution of technical problems connected with this development, and the new concept of the solution of technical problems in general.)

Creation of automatic enterprises does not signify that production will be achieved entirely without human participation. Even the most modern automatic mechanism requires now and will require in the future at least a periodic inspection, adjustment, and repairs. It requires and probably will frequently require in the future the labor of man for the liquidation of extreme deviations and obstacles which could not be foreseen in the automatic programming of the work of the mechanism. And in any event, even the most perfect automatic mechanism requires that a definite program of action or at least ultimate parameters of the industrial process be supplied to it by man. Upon a drastic increase in work productivity automation changes the part played by human labor in the industrial process and gives predominance to the preliminary preparation for the production, repairs, and adjustment of the automatic system of the machines and not to labor at the bench. The mechanism does not replace men, it only multiplies the productive power of work and the power of men over the forces of nature. Even the most perfect, fully automated factory without man will become only a useless pile of metal.

Automation advances on a broad front in various directions which are established by the conditions of technical development of individual branches of industry and individual plants. As it has been mentioned earlier, automation poses basically three main problems: firstly, the achievement of an automatic cycle of the work of a machine or an assembly, i.e., execution of the required group of operations in the prescribed sequence without direct participation by man; secondly, continuous automatic control and with it, the correction of the functioning of a machine; thirdly, automatic selection of the optimum program of operations. In solving the first problem the machine essentially replaces the physical labor which was formerly used in feeding the machine, transportation of the material and unfinished products within the shop, starting and stopping the separate elements of the machine, etc. In the second and third assignments the machine replaces certain sectors of mental work which up to the present time were performed by the operator attending the machine in the first instance and by the technical management of the establishment in the second instance.

If automatic control and regulation of the technological process is to be at all practicable, this process must not require employment of physical labor as a connecting link between the operations of the mechanisms. In modern industry the machines perform the principal production operations automatically in most instances. However, as long as the individual machines are isolated independent units, even when the work cycle of each of them is fully automated hard physical labor must still be used for charging the machines and moving the materials and

semi-finished products within the shop. Only unification of the individual machines into assemblies and systems of machines which perform all operations beginning with the delivery of the raw materials and ending with the production of the finished goods actually completes the liquidation of physical labor in the industrial process and its replacement with the work of a mechanism. In actual practice this is achieved either by concentration of all necessary operations in one assembly (for example, automatic machines for the manufacture of bottles, matches, etc.), or incorporation of a number of machines into a production line. Such installations are termed cyclic automatic machines.

The cyclic automatic machine or system of machines performs all the necessary principal or auxiliary operations of the production cycle according to a prescribed program and does not require the use of physical labor as a connecting link between individual operations of a machine. However, even the most perfect machine and the most stable technological process after a certain time deviate from the prescribed program under the influence of avrious conditions (for example, different quality of the material, blunting of the cutting tool, etc.). The quality of the products deteriorates, rejects appear. Each machine, therefore, requires control and regulation which can be performed either by the servicing personnel or by special devices, i.e., automatically. With the increase in the complexity of the technological process and the number of operations concentrated in a single system of machines, other conditions being equal, a reliable system of control and regulation becomes proportionally more indispensable.

The usual controlling devices keep track of the work of the mechanism and, in case of deviation from the normal course of the production process, either signal this fact in a certain manner or stop the mechanism. Thereupon the operator can adjust the course of the process according to the data of the control devices. Such devices are found even on automatic production lines and assemblies. This obviously is not complete automation inasmuch as the correction of error requires the interferences of the operator. In automatic control and regulation the so-called feedback must be put into practice whereby the automatic system itself controls the production process by comparing the method by which the operation is actually performed with the method by which it must be performed and thereupon automatically corrects the deviation in the work of the mechanism. Such an apparatus does not require interference by man and works much better, with greater precision and speed than the most experienced and qualified operator.

It is precisely because of this that automatic control and regulation afford carrying out superfast processes in which the deviation from the prescribed program must be discovered and corrected in the course of a fraction of a second, or of the complex processes during the regulation of which a large number of values and their mutual relationships must be taken into account. It was impossible to put such processes into practice under the conditions of manual control and regulation.
To the three factors forming the system of machines mentioned by Marx (See K. Marx, Kapital, Vol I, pages 378-379) (the working machine, transmission, and motor), the development of automation adds a fourth factor,

namely the sum total of automatic devices which provide the control and regulation of the production process without direct participation by man.

Automatic control and regulation together with the cyclic automatic machines represent the technical characteristics of the modern automatic systems and are, we might say, the first and lowest stage in the automation of production processes. This first stage of automation attains its highest level in the production process which takes place without the participation of physical labor and is equipped with automatic controls and regulations at individual working positions. The entire control over this process is concentrated in the central control panel. This allows the operator to observe the course of this process and when necessary to take measures for achieving the prescribed working conditions. Such automation of the production process exists now in many plants of various branches of industry.

However, the more complex the production process, the more difficult it is for the operator to establish and maintain the optimum mode of operation. The course of the process is affected by an appreciable number of values related to one another in manifold ways. The increasing speed of production processes in many instances requires that the operator solve extremely complicated mathematical problems within seconds or even fractions of a second. This, of course, is impossible for a man and in such instances the operator acts merely on the basis of his accumulated experience. However, it must be borne in mind that this empirical solution is not always the best solution. When many assemblies are integrated into a single automatic system and when even the slightest deviation from the optimum mode of operation or the slightest delay in the necessary interference with the course of the process lead to enormous losses and often even threaten the safety of the plant, the empirical, random solution is inadmissible. Hence, the more rational procedure is the conversion to a new higher stage of automation of production processes, the replacement of the operator directing the process from the central control board, by an electronic computer. This, again, is the so-called feedback principle which is now achieved not on a single operation but on the shop or plant scale and, therefore, is incomparably more complex.

The use of electronic computing devices for the control of the production processes will afford the creation of a fully automated factory operating in certain instances "under lock." However, for the time being the significance of electronic computers in introducing automation into industrial practice is less than the significance of cyclic automatic assemblies and automatic regulation. At the present time electronic computing devices for the direct control over the production process under industrial conditions are used only on rare occasions and their use is still in the experimental stage, as we can judge from the press notices. However, we can say that in the future the center of gravity of automation and the center of attention of technological sciences will certainly move into the sphere of industrial utilization of electronic computers, which opens new enormous possibilities of technical development.

Although the fully automated factory exists essentially only in a distant long-range plan of the technical development, the results of today's automation represent a new stage in the technical development and a sharp increase in the productivity of human labor. These results bear witness to the unbounded possibilities for technical progress opened by automation.

2. Achievements of Automation in Individual Branches of Economy

The development of automation can be visualized as the transition, firstly, from individual machines to automatic production lines and assemblies, subsequently, from individual automatic production lines and assemblies to automatic shops and divisions and, finally, to the unification of automatic divisions and shops into fully automated factory. At the present time almost all branches of industry use automation but the degree of its development in each branch of industry varies greatly. Thus, in the majority of branches of industry the problem consists of the creation of automatic production lines and assemblies and in the gradual unification of these into automatic shops and industrial divisions, whereas in some branches of industry the transition to the organization of automatic plants is beginning.

The most advantageous factor of automation lies in the continuity of the industrial process. The continuity of the production process is, so to say, the supreme principle of machine technology.[4] /See Note/ Certain industrial branches or, to be exact, certain industries realized the principle of continuity in various degrees.

(/Note/ "The combined working machine which at the present time is a dismembered system of heterogeneous individual working machines and groups of machines is as perfect as the entire process performed by it is continuous, i.e., in proportion to the shortness of intervals interrupting the continuous flow of the raw material from the first to the last stages of the process..." (Kapital, K. Marx, Vol 1, page 386). "The most perfect and the most productive machine is the one which is capable of uninterrupted production" (K. Marx, Notes on the Problems of Technology," Quotations according to "Bol'shevik," 1932, Nos 1-2, page 18).

The survey of the principal achievements of automation in individual industrial branches of national economy is given below in a very concise form. We must note that the purpose of this survey is certainly not the detailed study of the state of technology and of the possibilities of automation in all branches of national economy or even in individual industries of these branches. Its only purpose is the general characterization which would afford a certain summation of the significance, present state, and probable extent of subsequent development of automation. We must add that the achievements of automation which will be adduced on the following pages cannot serve to any extent as a criterion of saturation of any branch of industry by automatic devices. They represent merely individual achievements, the separate peaks of technical progress and on

their basis we can judge on what scale the automation has been introduced and whether it is feasible to use automation in individual branches of industry, but we cannot judge of the extent of the utilization of any one technical achievement.

Power engineering is one of the branches of industry in which automation has attained its highest development. In all the principal industrial countries of the world automation of individual technological processes is widely applied in power engineering, especially in electrical power engineering, and the conversion to complex automation of individual power stations, electrical networks, electrical circuits, electrical district heating networks, etc., has already begun. The task for the immediate future is the creation of a completely automatic united power system in which not only all the numerous power stations and substations will be automated but their modes of operation will be automatically coordinated by electronic computers.

Subsequent development of automation in power engineering is technically indispensable because the conversion to large assemblies, high parameters of steam in thermal power stations, etc., to say nothing of the building of atomic power stations and creation of high capacity unified groups of power networks, cannot be achieved without automation.

Automation on hydraulic power stations today does not present any great technical difficulties and the problem is principally reduced to the improvement of quality and a further perfection of the automatic equipment. In the USSR, for example, as early as 1 January 1956, 98% (by capacity) of the units of all hydroelectric stations of the Ministry of Power Stations were equipped with automatic control and 65% (by capacity) of the hydroelectric stations were equipped with remote control. As a result, the watch on large hydraulic power stations consisted of 4-6 men, on medium ones of 2-3 men, while in the machine rooms there are no attendants at all; they remain only at the control boards. Fifteen hydroelectric stations of 20,000 kw capacity generally work without any station personnel on constant duty.

The automation of electric networks and electrical sections of thermal power stations is extensively developed. Here, as well as at hydraulic power stations automation will be developed mainly in the direction of improving the quality and further advancement of automatic devices.

Industrial technology at thermal stations is more complicated than at hydraulic stations. Therefore, it is also more difficult to introduce automation at thermal stations. Today automation is used in individual technological processes there, for example, in the automatic regulation of the supply of water to the boilers, the automatic regulation of combustion, the automatic regulation of the temperature of superheating of steam, the automation of coal dust mills, the automation of chemical water purification, etc. The principal goal of subsequent development of automation in thermal stations is the conversion from the automation of individual processes and divisions to a complex automation with the control of the entire station concentrated in the hands of one man.

Chemical and oil refining industry has now attained a higher level of automation than the majority of other branches of industry. The conversion from the batch method to the continuous flow has been achieved in most of the technological processes of this branch of industry some time ago and has required an appreciable number of automatic devices regulating pressure, temperature, amount of materials, etc. The utilization of a certain number of automatic devices in the chemical and oil refining industry did not represent anything new and today is, we might say, a component of traditional technology, a condition of the normal work of an enterprise.

The modern level of technology in this branch of industry is characterized by the transition from automatic regulation of individual parameters to a complex automation of individual instruments, divisions, and even entire factories. The chemical and oil refining industry has many plants in which automation has attained a high level. However, in order to achieve complete automation in this branch of industry it is necessary to solve many important and complicated problems.

Firstly, the production process here is not controlled directly even now; individual aspects of the operation (temperature, etc.) are controlled, but not the quality of the product. There are practically no reliable devices for a continuous automatic chemical analysis of the raw material or product in the course of the process. Individual devices of this type which have lately appeared in the industry throughout the world have relatively narrow fields of application. Consequently, most of the processes require periodic laboratory analyses of samples of raw materials, semifinished materials, and finished products, which in essence are performed manually. Operators, in their turn, depending on the changing results of laboratory analyses change the prescribed programs of the automatic regulators. This is done manually also.

Automatic control and regulation systems in the chemical and oil refining industry today work according to a rigid program, i.e., they must maintain a predetermined constant quality of the products. However, the quality of the raw materials and other working conditions of the apparatus fluctuate within certain limits. Because of this the predetermined quality of the product is not always the best. In order to solve this problem it would be advisable to introduce into the system of complex automation a specialized computer which would adapt the flow of the process and the programs of individual regulators to the changing conditions. At the present time such automatic systems are still in the development stage.

Automation in the chemical and oil refining industry will, without doubt, develop at a rapid pace and the conversion from the automation of individual sections to the complete automation of plants is a task to be completed within a few years from now. Whereas in some other branches of industry automation is merely profitable in terms of savings, in the chemical industry it is, moreover, technically indispensable. An automobile engine or canned meat, as far as technology is concerned, can be manufactured either automatically or nonautomatically, but the

ever increasing number of chemical industries, such as the production of caprolactam, polyethylene, synthetic alcohol, synthetic rubber, and high-grade petroleum products, cannot be operated without automation. Automation is an indispensable condition for the further development of the chemical and oil refining industry.

According to experts' computations, a modern oil refinery is now 80-90% automated. For example, several sections of the Esso Petroleum Co. at Foley, England achieved a very high degree of automation. In the distillation division which processes 25,000,000 liters of oil per day only 6 operators per shift are working and their production by weight equals about one third of the internal consumption of petroleum products in Britain. At the oil refinery at Sarnia (Ontario, Canada) of the Sun Oil Company, Ltd. with a capacity of 800,000 tons per year all operations in all the technological divisions are handled by 10 man shifts (this number does not include the maintenance personnel).

In the oil refineries now under construction in the USSR all production processes, including the auxiliary processes, will be equipped with complex automation. Problems connected with the use of computers for controlling the characteristics of the mode of operation of processes are being currently worked out.

Elsewhere in the world there already exist some examples of fully automated systems used in the transportation and storage of oil and petroleum products. Such systems, including oil pipelines, pumping stations, and oil storage, are controlled from a single location sometimes hundreds of kilometers distant and the mechanisms require only periodic inspections. During the 1959-1965 period the processes of production and transportation of oil and its products in the USSR will be completely automated.

In the chemical industry automation is appreciably expanded in the production of sulfuric and nitric acids, carbon dioxide, superphosphate, soda ash, chlorine and chlororganic products, synthetic fibers and plastics, synthetic rubber and synthetic alcohol, aniline, rubber articles, etc.

For example, in the USA one of the largest sulfuric acid plants using natural sulfur is operated by only one man per shift. The automated plant of the Liquid Carbonic Co. in Oakland, California, producing 60 tons of carbon dioxide daily is run by only one operator per shift.

In the present day chemical industry of the USSR large combined operations on automatization of the most important productions are in progress. These are extensively developed especially in building plastics plants. According to plan, by 1965 not less than 95% of their entire production will be automated. By the end of the seven year plan the production of synthetic rubber and alcohol in the Soviet Union will be completely automated.

Machine building. The achievements of automation in machine building are well known. An opinion exists that it is precisely in this industry that automation has attained its greatest development. Actually this is not the case. Even in automobile construction which is the most highly developed machine building industry the level of automation is

below a great number of chemical and other industries. However, the great attention which is given to automation in machine building is well justified.

Automation changes sharply the entire concept of the technological process in machine building, where even today the discontinuous method of production predominates and certain elements of the line production method are applied only within the bounds of individual shops. In machine building establishments the equipment was distributed in groups according to the types of machines or the type of technology, and the technological process was regarded as a series of separate operations. A machine building plant represented a number of various shops, for example, casting, machining, heat treatment, pressworking, painting, assembling shops, etc., assembled in one place. All these shops were in essence technically independent units.

Automation radically rejects this concept of production and requires conversion to a continuous, line production. From an assembly of almost entirely independent shops a plant is converted into an integrated whole, a technical entity where the technological process continues uninterrupted. Thus a Soviet automated plant producing automobile engine pistons is a single automated line in which casting, heat treatment, machining, tinning, and a number of auxiliary operations such as washing, packing, weighing, determination of hardness, control of linear dimensions, etc., are performed. Were the plant operated according to the traditional technique, these operations would possibly be performed in four, five, or more shops.

In all countries with high industrial development, machine building is one of the principal branches of industry and changes in this industry have a great significance in the national economy. We well know that machine building includes various technological processes (machining, pressoworking, heat treatment, casting, plating, assembling, etc.) and various types of industries, from individual production "custom made" through small-lot and large-lot production to mass production.

At the present time automation is used mainly in large-lot and mass production. It attained wide development in the automobile and tractor industries, in the production of agricultural machinery, electric motors, office machines, bearings, textile machines, vacuum cleaners, sewing machines, refrigerators, washing machines, bicycles, radios, televisions, etc. Heavy machine building with its typically piece and small-lot production is as yet untouched by automation.

In mass and large-lot machine building production there exists a great number of automatic production lines and units in most instances executing a cycle of operations of a single technological type. For example, at the Soviet machine building plants there are today several hundred automatic production lines which process cylinder blocks, pistons, springs, automobile wheels, etc. The French automobile firm Renault upon modernization of its plants uses only 80 automatic production lines in the manufacture of its "Frigate" automobile.

Most of these production lines perform various machining operations, but there also exists an ever increasing number of automatic production lines in foundries, as well as production lines and assemblies for automatic stamping and welding, for plating, hardening, painting, etc. For example, casting into shell molds is wholly automated at the casting division of the American firm Link Belt Co. The production process is automated from the preparation of the molding sand to the operations with the finished castings. An automatic line producing 240 castings per hour is attended by two operators.

At the American "Oldsmobile" automobile plant an automated shop for plating the front and rear car bumpers is established. The output of the shop is 300 bumpers per hour. The automated shop with a 1.5 km long transportation system performs the following consecutive operations: copper plating, polishing, washing, nickel plating, chromeplating, and heat treatment.

Complex automatic production line uniting diverse technological processes are frequently built subsequent to the automation of individual technological processes. In such production lines the products continuously and automatically pass through pressworking, machining, heat treatment, washing, painting, and other operations. As an example of such a production line we might mention the wellknown automated shop for the production of ball and roller bearings at the First State Bearing Plant in Moscow. The shop is equipped with two automatic production lines where all operations of machining, heat treatment, control, assembly, and packing of ball and roller bearings are automated.

Automation of assembling operations at the present time lags far behind the automation of other technological processes in machine building and is, we may say, the weakest link. Only the automation of individual simple assembling operations, for example, the assembly of bearings, spark plugs, etc., has so far been achieved. At the Gor'kiy Automobile Plant automated production lines have been constructed for stamping and assembling the honeycomb plates of triple water radiators of the GAZ-51 automobile.

In 1958 in Khar'kov the All-Union Scientific Research Institute for Electrical Machinery and Instrument Construction designed an automatic line for assembling electric motors. A finished 20 kw electric motor will leave it every 52 seconds. This line represents a significant achievement in the automation of assembling operations.

In the production of radios, television sets, radar units, etc., a new technology has appeared which affords a complete automation of assembling operations. This new technology which consists of the utilization of the so-called printed circuits yields a manifold increase in labor productivity. An American automatic unit which assembles complex electronic items produces in a little more than one minute the same number of items as a worker produces in one day. The capacity of the unit is 200,000 assemblings per month; it is attended by three men.

Recently a tendency has appeared for the construction of automatic production lines which manifest great flexibility. In contrast to the

original automated lines designed principally for processing a single item, the new automated lines are constructed in such a manner that they can be used for processing a group of similar items. The feasibility of quick readjustment of such production lines increases appreciably the sphere of their application. A new arrival among the automation methods is the creation of rotary production lines. In these lines the processes of treatment and transportation are combined, as a result of which the equipment is utilized with almost 100 per cent efficiency. Experience in the use of rotary production lines is being gathered in the Novosibirsk economic region.

Today automatic production lines are principally used in mass and large-lot production and, therefore, they may be utilized only in certain machine building industries. We may say that they represent the initial trend in the development of automation in machine building, the trend, which up to now, has attained the greatest development.

In many machine building plants mass production methods cannot be applied. However, here too, a way is open for introducing automation, namely, the second trend in the development of automation in machine building, termed the programmed control. It affords an appreciable increase in the productivity and precision of the work of a machine as well as its rapid readjustment. It is well known that in the production of precise and highly complex elements the capacity of a machine is not fully utilized. A great amount of time is lost by the operator in reading the blueprint and selecting the optimum method of operation of the machine. The principle of programmed control lies precisely in the fact that the selection of the optimum mode of operation of a machine is performed prior to the beginning of the operational process, while the information on the shape and dimensions of the item, the method of machining, and the sequence of operations is relayed directly to the machine and not given to the operator in the form of a blueprint.

The application of the principle of programmed control is not limited to the production of very complicated items or to operations requiring extremely high precision. It can also be applied in less complicated current operations, essentially in the instances where the universal machines are now used and the chief requirement is the feasibility of a rapid transfer from the production of one item to the production of an item of a different shape and dimensions.

At the present time numerous various types of turning lathes, milling, drilling, and other machines equipped with program control have been built. The operation program of these machines is recorded on a perforated paper tape or card, on a magnetic tape, etc. The punched cards and magnetic tapes incur almost no wear and can be kept a very long time, hence a single copy can be used for the production of a great number of similar items which are reproduced during a certain period of time.

The creation and further development of program control machines probably opens a way to the extensive application of automation even in small-lot and piece production.

In metallurgy automatic devices predominate. It would probably be relatively difficult to find anywhere in the world a metallurgical plant in which no automatic devices are used. In the degree of utilization of automatic devices metallurgy, probably, not only rivals the chemical industry but even surpasses it. For example, approximately 90% of steel in the USSR is produced in open hearth furnaces equipped with automatic control and regulation of thermal conditions.

However, the contemporary system for the production of steel billets consists of several separate stages, namely, the preparation of iron ore for the blast furnace (i.e., concentration and agglomeration of the ore); the preparation of coal for the blast furnace operation (i.e., reduction and coking of the coal); the production of pig iron in the blast furnaces; the production of steel in open hearth furnaces and Bessemer converters; casting of steel in ingots; rolling of ingots into billets. With a few exceptions the technological processes in the various stages exhibit a typically cyclic, discontinuous character.

In most individual stages the production of steel billets uses an appreciable number of automation devices. The application of automatic devices and units in these processes manifests great significance, namely, it increases the productivity and reliability of the work of units, improves the quality of the products, improves the working conditions for the personnel, affords an economy in labor, fuel, raw materials, and power. In the future, without doubt, the application of automatic devices in individual stages of the production process in ferrous metallurgy will develop at a rapid rate. This will result in a further improvement of the technical level in the metallurgical industry and in the productivity of the metallurgists' work. However, in spite of a large number of various automation devices the production of steel billets is not automatic and it will not become automated merely when further automatic units are introduced into the various stages of the production process. The path toward a complete automation in metallurgy apparently requires a radical change in the technology, the elimination of discontinuity and the conversion to a continuous production process beginning with the ore and ending with the ingots or the rolled stock.

In ferrous metallurgy the problem of development of a new continuous process of production of steel semi-finished products (ingots, rolled stock, shaped castings) directly from the ore is yet unsolved. The work in this direction has not yet left the experimental stage. Practical introduction of automation today follows a different direction, namely, the use of automatic units at separate stages of the existing technological system.

In this sense appreciable successes have been already achieved. In the blast furnace industry, for example, the assembly and weighing of the charge and charging of the blast furnaces are automated to an appreciable degree; the regulation of the temperature of the hot blast (in all blast furnaces in the USSR), of the pressure in the charge hole, of the moisture content of the blast, and of the mode of operation of air preheaters, etc., is extensively automated.

Automatic regulation of thermal conditions, i.e., of the pressure, temperature, and fuel consumption is used in the open hearth production. At one of the furnaces in the Kuznetskiy Metallurgical Combine the system of an automated programmed variation of the thermal conditions according to the periods of the smelting process has been introduced. The steel worker sets the duration of each period of the heat at the corresponding timing relay and selects the number of the program of combustion according to the grade of steel required. The conversion from one program to another is performed automatically.

Full automation of the metallurgical processes, however, is probably connected with the conversion to a continuous production process. The existing conditions do not warrant this at the present time, but certain new technological processes of casting and rolling, which appeared in recent years, support in principle the feasibility of creating a continuous process of production flow in metallurgy. We are speaking of continuous casting of steel and continuous-action rolling mills. The continuous character of these processes afforded a successful solution of the fundamental problems of their automation. It is very likely that in the future a continuous casting machine will be combined with a continuous rolling mill. This will result in the complex automation of the entire process beginning with casting of steel and ending with rolling the finished products. Thus even today certain new achievements in individual sections of industry are approaching the solution of the problem of creating a continuous fully automated process in ferrous metallurgy.

In nonferrous metallurgy we are probably very much nearer the solution to the problem. Even now continuous processes predominate in certain nonferrous metal industries and in the USSR, for example, a complex automatic continuous flow sheet for the production of blister copper from sulfide ores has been developed. The flow sheet includes storing of concentrates, fluxes, and limestone, neutralization of the charge, granulation, drying and roasting in the "rimming layer," smelting in reverberatory furnaces, and production of blister copper in a horizontal converter. The system provides for the introduction of a computing device for determining the sulfur content of the charge and selecting the optimum operating conditions based on this result. The flow sheet for a complexly automated lead plant has also been developed. In certain branches of nonferrous metallurgy the technical level, the accumulated experience, and the results of research permit even at the present time to begin the transition from the automation of individual assemblies and operations to automation of shops and technological processes and to the creation of complex automated enterprises.

The mining industry. The technological process in the mining industry proceeds under complex and changing conditions. The changes in the mechanical properties of the rock being broken up, in the direction of the layer, in the thickness of the deposits, in the underground pressure, etc., have a decisive effect on the course of the technological process. These changes, their character, and direction cannot always be

established beforehand and, therefore, the problems connected with the selection of the correct method of operation under changing mining conditions in many instances must be solved by the worker on the basis of his knowledge and experience. This, of course, impedes greatly the introduction of automation in coal and ore mining. Therefore, the mining industry was for a long time considered to be a branch of industry not suitable for automation on any appreciable scale.

At the present time automation in the mining industry embraces a number of auxiliary operations: pumping, ventilation, separate sectors in the transportation of coal and rock, etc. Soviet science and technology have already attained appreciable success in solving complicated problems in mining of minerals. For example, we have designed automatic assemblies which simultaneously perform cutting, loading, and transportation of coal along the cut, as well as its loading onto the conveyor belt of the drift; and which in addition control the roofing operations and move the bracing. The means for the automatic control of the movement of mining machines according to a prescribed directive, devices directing the machines precisely along the boundary between coal and rock, automatic regulators for loading mining machines, and other means of automation have been designed. Systems and plans for complexly automated mines and shafts have also been created. We begin to put into practice the progressive idea of production of coal and ores from mines without any men present in the cut.

Building material and construction industries. In the building materials industry automation has attained a relatively high level. This is due to the uncomplicated technology, mass production, and continuous process in most branches of this industry. Certain products in the building material industry have the best prospects for automation.

A good example of automation of this industry is a polished glass factory with a continuous production line of founding, rolling, and fritting of glass and a conveyer system for grinding and polishing. Here all operations beginning with the preparation of the charge and ending with washing and drying of the polished glass are automated. One of such highly automated plants is, for example, the Saratov commercial glass plant.

At an experimental cement plant which is now being designed in the USSR it is planned to increase through automation the annual production of cement to 5,000 tons per worker, whereas at other plants the annual production does not exceed 2,000 tons. Examples of automation exist also in the production of sewer pipes, certain ceramic products, steam radiators, hardwood flooring, door hinges, plywood sheets, as well as the production of lime, brick, and asbestos-cement items.

Whereas the development of automation in the production of building materials and various construction items and units does not encounter great difficulties and has at present attained significant success, automation of the building process itself is not yet possible. Construction is still in the stage of transition to the industrial forms of production and this transition is far from complete. Automation is the technique of large mechanized industry and not of primitive or semi-primitive production.

In the future the building industry will probably use prefabricated standard parts and units more extensively. In this connection a major portion of the technological processes of construction will be achieved under purely industrial conditions in large, specialized factories, which in fact will permit the automation of these processes. The field of construction, as such, will be reduced in essence to the process of assembling the standardized parts. This assembling will be completely mechanized but probably not automated.

Light and food industries. In this branch of industry, along with factories which are essentially ready for complete automation and are even now to a large extent automated, there are also some plants in which automation is not practicable without a radical change in the technological process. There are industries which manufacture standard mass production items (for example, matches, pencils, oil, sugar) and at the same time there are industries the products of which change in the course of a few months because of changes of fashion or tastes of the consumers (for example, the shoe and clothing industries).

In the food industry, we might say, automation encounters extremely favorable conditions owing to the highly standardized nature of the products, a relatively uncomplicated technological process and a high degree of continuity of production. Automation in the food industry is not only economically profitable but at the same time increases the level of hygenic and sanitary conditions, affords a strict adherence to the recipes and reduces appreciably the time necessary for processing the raw materials, thus ensuring the conservation of valuable nutritive properties of the food products.

Many automatic production lines, units and divisions exist today in various establishments of the food industry, in the production of butter, milk, cheese, chocolate products, candy and caramel, canned meat, wieners, bread, biscuits, marmelade, beverages, etc. Automatic lines for the production of wieners, which have been established at certain plants in the USSR include the injection of the filling into the casing, twisting of the wieners, and heat processing, i.e., frying, parboiling and cooling. This decreases wastes by 50% and heat consumed by 66%, shortens the process by 66-75%, and requires an 80-90% smaller production area.

We must stress, however, that in the instances when the control of the quality of the product is performed only through purely subjective appraisal (i.e., according to taste, odor, outer appearance, etc.) automation is not possible since the empirical criteria cannot be measured with instruments. In these instances the indispensable condition for automation must be a more profound scientific knowledge of the technological process itself.

In the woodworking industry favorable conditions for automation exist in plants which specialize in mass production of standard articles, for example, in the pencil and match industry and also in serial production within the furniture industry.

In the textile industry individual automatic looms of varied specialization are used on a large scale. Many of these looms are highly

dependable and productive and require only periodic control and inspection by the operator. In the USA, for example, one operator in a cotton weaving factory attends to 104 automatic looms. However, complex automation combining individual automatic looms into a continuous automatic production line, including all stages of the technological process, does not yet exist in the spinning, weaving, or knitting industry. The only exception is the production of synthetic fiber which is automated to an appreciable degree. Advantageous conditions for complex automation exist also in the finishing department and in many countries there exist various automated lines, primarily in the processes of bleaching and dying of the cloth. However, the spinning industry presents great difficulties in automation owing to the discontinuous nature of the technological process and will probably require radical changes in its technology.

The shoe industry attained an appreciable degree of mechanization but a conversion to automation here encounters especially great difficulties because of the character of the technology and the extensive and rapidly changing assortment of the product. It is quite probable that in the future the production will develop here along the lines of partial automation. The exception here is the production of rubber footwear which has a number of various automatic production lines and assemblies throughout the world and which is fundamentally ready for complex automation.

Transportation and communications. In railroad transportation various types of automation and telemechanization are widely applied.

Automatic locomotive signalization ensures the transmission of signals to the locomotive signal lights in the engineer's cab. The automatic stopping device connects the signals with the braking system of the train and stops the train upon its going past an automatic block signal. This increases traffic safety and improves the conditions for running a train.

Electrical centralization of switches and signals permits one man to throw the switches and direct the signals of an entire station from a central point. The most modern systems afford the performance of all switching operations and manipulating the signals by pressing two buttons: one at the beginning of the run of the train and the other at its end. The rest is done automatically by the system. The electrical centralized traffic control affords a 50-70% increase in the traffic capacity of a station and a reduction of the attending personnel by 30-50 men per 100 switches.

The distributing stations are to a great extent automized. In the USSR and the USA work on the complete automation of distributing operations by means of computers is in progress.

In communications the elements of automation were applied for a relatively long time and today automation is widely expanding in the telephone, telegraph, and photo-telegraphic communications. Some stations with 1,000-2,000 number capacity operate without continuous attendance. In some countries work toward full automation of inter-city telephone and telegraph communications is in progress.

Office work is now the principal sphere for applying the means of the computer technology (we are not speaking here of the application of computers in scientific research calculations or in the military field). Whereas in industrial process management electronic computers are used only in exceptional instances and only as an experiment, in bookkeeping, accounting, and other kinds of office work they are quite prevalent and produce a veritable revolution in the methods of work.

Actually, the use of computers in certain operations has today afforded a reduction of 90-94% in personnel requirement. Certain writers in capitalist countries think that these and other machines will in the future replace 80% of secretaries, bookkeepers, typists, accountants, and other office workers in various establishments.

Automation is applied to office operations which exhibit a completely regularized, standard, we may say, pattern character; precisely such operations constitute the majority of office chores. If they are to be presented schematically, they will all be reduced to selection, processing, and storing of information of various types. These operations can be performed automatically by means of electronic computers connected to various ordinary office machines (typewriters, accounting machines, cash registers, etc.) and forming a single automatic entity.

Automation is already used in various bookkeeping operations in planning and economic calculations, banking operations, insurance operations, statistics, etc. Thus, for example, there are examples of automation of operations in wage computation, including overtime, taxes, and other calculations, and the printing of payrolls and pay checks; operations of registration of equipment and materials, or inventory taking, of inventory control; operations of compounding the balance; costs calculations; control of transportation and commercial operations; the preparation of reports for the future requirements of raw material, labor, possibilities of sales; banking bookkeeping operations; analyses of the economic activity of the establishment, etc.

Several examples will help to explain the enormous possibilities of computation technology in office work. Thus, the American firm General Electric purchased in 1954 a "Univac" electronic computer. This machine performs all the bookkeeping calculations of five independent divisions of the firm, computes the salaries and wages of 12,000 workers and employees, including overtime earnings and deductions, prints payrolls and paychecks, performs operations on the registration, inventory and control, and also calculates production expenses and computes the profits received. Ordinarily several hundred employees are needed to perform this work.

The British trading firm Lyons has a large "LEO" computer. This machine calculates the wages and salaries of 10,000 people, daily analyzes the work of all the branches of the firm in London, calls the attention of the firm's management to the branch offices which suddenly exhibit good or bad results, keeps tab on the existing supplies, and performs many other operations. It has been calculated that "LEO" does the work of approximately 300 employees.

The Bank of America installed in the city of San Jose an electronic computer "ERMA-1" the assignment of which is the complete automation of accounting and bookkeeping operations in the bank. The machine processes 32,000 active and 8,000 clearing accounts. This corresponds to the volume of work of 12 medium-size branches of the bank. It is planned to install in the near future 300 more such machines in the main offices of the Bank of America.

There are many various forms of utilizing automation in various branches of the national economy. However, the examples adduced above show, in general, the significance and the state of automation and also permit us to draw certain conclusions.

It is quite obvious that the principal and decisive field for the application of automation is the processing industry. From the technical point of view almost all of its branches are today, to a certain extent, ready for automation. However, the branches of the process industry include two large groups which differ from one another in their preparedness for automation.

The first group consists of industries in which continuous production processes or production predominate, and where the conversion to an uninterrupted process does not represent any great technical difficulties. These are primarily power engineering, chemical and oil refining industries, nonferrous metallurgy, the rubber industry, the building materials industry, the glass and ceramics industry, the food industry, the paper industry, large-lot and mass production of machine building and woodworking industries, as well as certain sectors of ferrous metallurgy and the textile industry. In all these industries automation has already achieved appreciable successes and in all probability will develop rapidly in the future also. The technical possibilities for the conversion to a complex and full automation exist here in many instances or can be expected to appear within the next few years.

The second and considerably smaller group is represented by industries in which conversion to the complex or almost complex automation is not possible now and not probable in the near future. This certainly does not signify that in these industries the further development of automation is not possible. To the contrary, here automation will probably develop at a rapid rate also, but this development will more likely occur along the lines of partial automation. This group includes primarily the industries which do not as yet have the conditions necessary for the conversion to a continuous process, as, for example, in the production of steel or in the cotton spinning industry. Now, this group also includes industries in which automation encounters exceptional difficulties owing to the prevalence of individual and small-lot production (heavy machine building) or to exceptionally broad and rapidly changing stocks (shoe and clothing industry).

In most of the other branches of material production, i.e., in construction, agriculture, forestry, and the fishing industry, the technical conditions have so far excluded the possibility of a wide application

of automation. Automation is used here only in certain auxiliary processes and in the processing of raw materials produced, and these procedures can be more correctly classified as processing industry. Subsequent technical development in these branches will most likely follow the path of further mechanization and improvement of machines operated by the worker, and not the path of replacement of the worker by an automatic device. The exception is represented by transportation and communications, which today have many processes which are technically ready for automation. The same can be said of the mining industry which is now beginning to use automation on an appreciable scale and the feasibility of its conversion to complex automation has already been proved in practice.

Automation has achieved great successes in the field of distribution. At the present time the automation of many bookkeeping, planning, accounting, banking and insurance operations is entirely practicable. There are examples of complete automation of warehousing operations based on the continuous flow principle. The numerous automatic devices in retail trade are well known, for example, automatic dispensers for the sale of chocolate, candy, canned goods, cigarettes, matches, postage stamps and envelopes, subway tickets, etc.

Thus, we may say that most of the plants of the processing and mining industry, many transportation and communications processes and a very significant portion of distribution operations are from the technical point of view either entirely or almost entirely prepared for complex automation. Other plants and processes of these branches are also using automatic devices, however, in the immediate future, they will be only partially automated. In construction, agriculture, forestry and fisheries we cannot as yet expect automation to be introduced on a significant scale, although some elements of automation will certainly be used even in these branches.

We have stated that most of the process industry establishments and many other branches of industry are essentially prepared (or almost prepared) for complex automation. However, this does not signify that all the elements of automatic production do exist today and are only to be united in order to produce a fully automatic shop or plant. We have as yet no basis for drawing such a conclusion. Much remains to be done and many problems are to be solved. However, much work is being done in many places toward their solution and the results obtained indicate that the solution of these problems is feasible in principle and will probably be achieved in the immediate future.

In order to utilize all the possibilities of automation, in many instances it is necessary to create the entire technological process anew. It would be erroneous to assume that automation consists of a simple addition of automatic devices to the existing mechanisms or to the existing technology and in connecting these devices to a controlling machine. Such a solution might in many instances be entirely satisfactory, however, most of the traditional technological systems which until now were considered acceptable, require a radical revision from the point of view of automation. New technological systems must not only ensure the continuity of a process but must make the most of the opportunities

presented by automation.

The necessity for a radical revision of the traditional technology in connection with the adoption of automation does not preclude using the existing mechanisms for automation. Equipping the existing mechanisms with automatic regulators, automatic feeding devices, etc., and uniting the machines into automatic production lines can in certain instances be an entirely acceptable solution or at least a step in the direction of automated production.

If we take into consideration, for instance, the large quantity of metalworking lathes present in every industrially developed country, we must agree that a satisfactory technical solution will be one which would permit the conversion of these lathes to the automatic work cycle, unite them into automatic production flow lines by means of transportation devices, and equip them with uncomplicated automatic devices for feeding the equipment. This would appreciably expand the material prerequisites for automation in machine building and would increase the rate and extent of its adoption.

Utilization of the existing equipment for automation is without doubt quite rational and necessary; however, its significance should not be overemphasized. The utilization of the existing equipment frequently stands in the way of conversion from the existing technology to a more advanced one. In any case the modernization of the existing equipment and its utilization in automation represents only the auxiliary and not the principal trend in the development of automation.

One of the most important problems of further development in the technical means of automation is the problem of flexibility in the automated production, i.e., the feasibility of a rapid and easy modification of the production program. The solution of this problem is of extreme significance in respect to the further development of automation and the extent of its application. Only recently it was generally considered that automation decreases the adaptability of a machine or assembly; the greater the automation in the machine the more complicated and difficult was its reconversion (when it was at all feasible) to another program of work. It was for this reason that automation was considered practicable only in mass production.

It is quite true that an automatic lathe, or, for example, an automatic machine for filling bottles of beer, milk, etc., is very reliable and efficient; however, the readaptation of the lathe for the manufacture of articles of a different shape or the reconversion of the machine to filling bottles of a different size are connected with great expenditures in funds and time, and therefore, automation loses its significance in small lot production. This loss of flexibility is even more appreciable in automatic lathe series, and, since the cost of an automatic production line is much greater than the cost of each automatic lathe it is obvious that such production lines can be used only in mass production. For example, at the Scientific Convention on the Problems of Machine Building in the city of Aachen (West Germany) some speakers stated that from the point of view of economy, automated lines of lathes can efficiently produce only such articles which would be manufactured without changes for

not less than three years in batches exceeding 2,000 pieces per month.

However, mass production is only a minor portion of the entire production even in the leading industrially developed countries. Until recently this state of affairs was considered to be an unsurmountable natural limit to the application of automation. During the recent years, however, in all industrially developed countries a new tendency in the development of technical means for automation is becoming increasingly manifest. It is the tendency toward the construction of automatic devices of a greater flexibility and maneuverability which afford an easy and rapid modification of the production program.

The problem of the creation of more flexible automatic equipment is solved by proceeding in two fundamental directions. Firstly, the specialized automatic production lines or installations are formed of standard, unified, and normalized units or assemblies. This fact enables us to create a new automatic production line by changing the production line program by a simple replacement of individual units or by their rearrangement. The construction of automatic production lines of standard, unified, and normalized units and assemblies increases appreciably the flexibility of the automatic equipment, appreciably reduces the time needed for assembling a new automatic line, leads to a better utilization of equipment, and to the lengthening of the period of its useful performance.

The second direction in the solution of the problem of flexibility of automatic equipment is the creation of automatic equipment which under the conditions of high productivity would be universal within certain limits, and the program of action of which could be changed very easily, for example, by replacing a punched card or magnetic tape, pushing a button, etc. This trend is as yet weakly developed, however, certain examples of automatic devices of this type are already known in the industrial world. In the USA, for example, a fully automatic concrete plant which is capable of producing and loading into trucks, approximately 1,500 various grades of concrete is now in operation. The dispatcher located at the central station orders the delivery of the required grade of concrete by the simple replacement of a punched card containing the code for the production formula of the grade of concrete.

Machines with programmed directions which were mentioned earlier are also included in this trend of the development of the means of automation. Today there exist numerous various types of such machines ranging from relatively simple machines in which the mechanical programming devices of ordinary automatic machines which do not permit a rapid readaptation have been replaced with electrical or electronic control which permits the assignment of a new program to the machine by simple replacement of a punched card, etc., to complicated machines equipped with a system of active control and controlled by a continuous or digital computer. In general, utilization of computer technology in the control of production processes, which is the immediate problem for technical sciences, promises to solve in principle the problem of flexibility in automated equipment and in all probability will permit the creation of a system of machines which will not only be fully automatic but will exhibit great maneuverability and versatility.

Providing automatic equipment with flexibility extends the possibilities of application of automation not only in mass production but also in lot, small-lot, and even in piece production. Here, however, we must make a remark on the problem which has created an artificial confusion in foreign literature. Certain authors dealing with the possibilities of automation began to refute the advantages of mass production and attempted to assert that further development of technology will tend to erase the difference between piece and small-lot production and mass production. The practicability of automation of small-lot production is a matter of enormous significance. But this does not change the fact that large-lot production is more profitable than small-lot production and that mass production is more profitable than batch production. The transition from piece production through batch production to mass production represents the path of technical progress which is true for automation as well. Automation of small-lot production appreciably expands the potentialities of automation in the national economy and increases drastically the labor productivity in small-lot production, but it does not change the technical and economic advantages of mass production.

Extensive application of the block and assembly principle in the designing of automatic equipment, and the development of a system of strictly unified and normalized units and assemblies for different important purposes, which are most frequently encountered in various branches of industry, is a problem of exceptional importance. Up to now most of the automated equipment in the whole world was custom made. Hence, it is evident that the costs of automated equipment were high and that long periods of time were required for its construction. This fact limited appreciably the potentialities and rate of adopting automation. Adoption of the block principle and the use of normalized, standard units and assemblies which can be combined to produce various production cycles afford a decisive reduction in the time required for designing and building the automation apparatus. At the same time the application of this principle renders feasible the conversion to lot and mass production of automatic equipment and in this way, to the gradual automation of the production of automation instruments.

Of course, the solution of this problem is still in its initial stage. However, work in this direction is being carried out on a large scale in most of the industrially developed countries where the first steps in the transition to automation were made in machine-tool building and in electronic and electrical engineering industry.

The technical basis from which automation has originated and to a large degree is still developing, is not on the same level with the technical base. At the outset the major portion of automatic equipment was custom made, i.e., it was made, in principle, under the conditions of piece production. Today specialized plants for the production of automation instruments are gradually being developed. Specialization of the plants in conjunction with extensive application of block and assembly principles and an increase in the flexibility of automated production creates the conditions favorable to automation in the production of the means of automation. Thus, automation gradually encompasses its charac-

teristic means of production, namely, the production of automatic equipment itself. It must produce automatic equipment automatically in order to create an adequate technical basis and to stand on its own feet. It is hard to overrate the significance of this development which has already begun.

Thus, technical development opens enormous opportunities to automation and graddally eliminates and will continue to eliminate in the future all the limitations of a technical nature which yet exist in the subsequent development of automation of production processes.

3. Economic Impact of Automation

Automation presents to the human race enormous opportunities which as yet have not been fully revealed. The degree to which society can utilize these opportunities, the purposes for which automation will be applied and the effect which the automation of industry will have on society depend entirely on the industrial relationships existing in the country. Theoretical analysis and practical experience show that the conditions for the introduction of automation and especially its social and economic significance under socialism are entirely different from what they are under capitalism. Here the contrast between the socialistic and capitalistic methods of production is exposed with exceptional clarity. However, prior to the examination of the prerequisites and the significance of automation in the two different social-economic systems we must examine the potential capabilities of automation, i.e., its part in the increase of labor productivity of society, and its economic effectiveness.

The analysis of the economic impact of automation is at this time limited by the amount of available materials. Automation is still in the initial stages of its development and the conclusions of this analysis pertain to the present phase of the development of automation only. There is no doubt that in the future when instead of partial solutions of the problem an increasingly great number of plants and industries will be converted to full automation, when the technology, the designs of the machinery, and the finished product will be adapted to the requirements and potentialities of automation, then the economic effect of automation will be immeasurably greater than at the present time. Today it is yet difficult to determine how much greater it will be.

In order to analyze the economic impact of automation it is necessary to study the entire complex of economic indexes of the work of the automated sector, shop or plant in comparison to those that are not automated, all other conditions being equal. The difficulty, however, lies in the fact that in the world literature there are as yet very few accurate and comprehensive analyses of the economic effect of automation; in most instances only certain fragmentary indexes are adduced. Moreover, the economic indexes are often computed by diverse methods and thus cannot always be compared.

Therefore, the principal economic indexes of automation in various branches of industry and in different countries which will be adduced below can be regarded merely as illustrations. Nevertheless, they present a certain concept of the scale of economy of labor achieved today and in the past through automation.

The data on capital investments and annual savings resulting from automation of copper and nickel plants of the Noril'sk Combine computed for the long-range plan are given in Table 1. From the table we can see that the cost of all the work connected with the conversion to automation calculated for five years will be repaid in approximately 13 months in the copper plant and in 16 months in the nickel plant.

Table 1

Economic results of automation of the plants of the Noril'sk Kombinat, USSR*

(thousands of rubles)

	Copper plant	Nickel plant
1. Expenses to be incurred during 5 years for the automation of the plant		
(a) research work	4400	3400
(b) designing work	990	1340
(c) equipment and installation	8000	8765
(d) adjustment operations	1060	1258
Total expenses	14450	14768
2. Efficiency expected from automation		
(a) manpower reduction (men)	362	224
(b) yearly savings through reduction of consumption of raw materials and power, rejects, lost time, etc.	4150	5700
(c) annual savings in wages (all extras included)	9050	5600
Yearly saving	13200	11300

*Data taken from article by Bekenshtein, V. A., Feigin V. I., Popov V. M., Burovoy I. A., Puchkov S. G., Kleshko B. M., Korendyasev G. V., "Production of Nonferrous Metals", Symposium Avtomatizatsiya proizvodstvennykh processov /Automation of Industrial Processes/, Moscow, 1956, pages 127-128.

Table 2

Economic indexes of automated and nonautomated production, USSR

[See Note]

Indexes	1		2		3		4		5		6	
	7		8		9		10		11		12	
	13	14	13	14	13	14	13	14	13	14	13	14
1. Annual production per one industrial worker (pieces	24,770	91,650	6,000	20,000	1,125	28,400	1,040	10,790	3,963	10,900	3,580	8,700
2. Annual production per 1 sq meter of shop area (pieces	1,690	2,534	713	1,543	67	87	69	160	110	208	196	265
3. Cost of processing of one machine part (rubles)	3.88	1.94	5.33	3.91	43.87	28.95	200.0	161.6	8.07	6.78	9.77	7.50

[Note] Data from article by A. Vladziyevskiy "Technical-economic Effectiveness of Automatic Production Lines", Planovoye Khozyaystvo, 1958, No 7; and Tekhnicheskiy Progress v Stankostroyenii (Technical Progress in Machine Building) by A. Prokopovich. Moscow, 1957. pages 149-150.

1 "Altaysel'mash" plant ("Altay Agricultural Machinery" Plant)
2 "Krasnyy Proletariy" plant ("Red Proletarian" Plant)
3 Khar'kov "Serp i Molot" plant ("Sickle and Hammer" Plant)
4 KhTZ (Khar'kovskiy Traktornyy Zavod -- Khar'kov Tractor Plant)
5 Small displacement automobile plant
6 ZIL (Zavod imeni Lenina, Lenin Plant)
7 Production of chisel-type cultivating tines
8 Machining of gears
9 Machining of combine harvester engine block head
10 Machining of the head of the motor block of DT-65 tractor
11 Machining of engine block of the "Moskvich" automobile
12 Machining of the engine block of the "ZIL-150"
13 On individual machines
14 On automatic production line

In Table 2 the economic indexes of the automatic production lines in the USSR machine building are compared with the indexes of nonautomated industry. This comparison provides convincing proof in favor of automatic production lines. In analyzing Table 2 we find that the labor productivity at the Khar'kov "Serp i Molot" plant increased 25.2 times upon the introduction of automation and at the ZIL plant by 2.4 times. This is due to the fact that at the Moscow plants which have already been using highly productive automatic machines labor productivity increases less than at such plants where the level of skills in production has been lower.

Let us now examine the economic impact of automation of production from a somewhat different angle.

Table 3

Complex automation of the process of digestion of cellulose, USSR*

Effect of complex automation expressed in natural units	Economic indexes of the effect of the complex automation	
	lowering of costs %	reduction of production expenses per 1 ton of cellulose (rubles)
20% increase in productivity through reduction of digestion time.....	3.4	22.70
12% increase of yield of first grade product and reduction in yield of second and third grade products from 15 to 3%.....	3.6	24.00
4% economy of steam consumption.....	0.38	2.54
4% economy of the pulpwood.....	2.12	14.20
4% economy of chemicals.....	0.34	2.24
Total	9.84	65.68

*Data from the article by M. S. Voroshilov "Technological Systems and Conditions for Automation of the Cellulose-paper Industry", Symposium Materialy soveshchaniya po avtomatizatsii proizvodstvennykh protsessov v tsellyulozno-bumazhnoy i gidrolizhnoy promyshlennosti (Materials of the Conference on the Automation of Production Processes in the Cellulose-paper Industry), Moscow, 1956, page 24.)

Table 3 shows the effect that complex automation of the process of digestion of cellulose has on the reduction of the main elements of production cost. The economic effect was computed on the basis of the experience of adoption of complex automation at the Priozerskiy Plant and data reflecting the work of the leading digestion divisions.

Let us now examine certain data on automation in Czechoslovakia. Economic indexes of automated and nonautomated production of machining the connecting rods of diesel engines at one of the truck plants in Czechoslovakia are given in Table 4.

Table 4

Automatic Production Line for Machining Connecting Rods

Czechoslovakia

Indexes	Nonautomated production	Automated production
Production time (min)	19.1	1.8
Wages per 1 connecting rod (Czechoslovak crowns)	1.563	0.444
Number of workers (men)	20.4	3.8
Number of machines (pcs)	12	1
Labor productivity per 1 worker (%)	100	431
Production area (sq. meters)	134	72
Annual production per 1 sq meter area (tons)	3.8	7.2

Following is yet another example of economic effectiveness of automation of production processes taken from the sphere of food industry (Table 5).

In capitalistic countries very few detailed computations of economic effectiveness of automation have been published. Data on the economy achieved through the adoption of automation are kept secret by the industrialists for reasons of competition and primarily from the fear of the labor movement.

The most detailed data on the experience of automation in the industry of capitalistic states were published by the British "Austin Motor Company."

Table 5

Automation of Production Processes in the Dairy Industry

Czechoslovakia

	Wages per shift		Labor productivity of one worker		Volume or production per shift		Depreciation and repairs per shift	
	Czech. crowns	%	abs	%	abs	%	Czech. crowns	%
1. Production of pasteurized milk			liters		liters			
existing equipment	105.79	100	2500	100	40000	100	231.24	100
automatic production line	64	61	7500	300	60000	150	303.55	131
2. Production of hard cheeses			kg		kg			
existing equipment	292.91	100	102.5	100	820	100	70.76	100
automatic production line	152	51	205	200	1640	200	136.03	192
3. Production of process cheese			pieces		pieces			
existing equipment	884.66	100	216	100	3000	100	25.85	100
automatic production line	216	24	863	400	10000	333	120.82	467

The indexes of economic efficiency of the automated production line for machining cylinder blocks, which was installed at the plant of this company are given in Table 6. The line is attended by two operators (one loading, the other unloading the line). The operations now performed by this production line formerly required 13 machines and 13 operators.

The given examples of computations of savings in individual instances of automation permit us to draw certain general conclusions on the economic impact of automation. Let us attempt to examine the economic advantages of automation in comparison with the preceding technology, i.e., the direction and the amount of reduction in work done by man and machine through automation.

The experience in the adoption of automation shows primarily that the economic effectiveness of automation has many facets and only in exceptional instances can it be expressed by a single index.

The most obvious effect of automation is the sharp increase in operating efficiency i.e. in the production per one industrial worker per unit of time. The increase in operating efficiency resulting from automation is in most instances much greater than the corresponding growth of operating efficiency resulting from the "ordinary" technical progress in the past. Data adduced in Tables 1-6 verify the correctness of this statement. It is supported by a number of other facts. Thus the study of 21 instances of automation in various branches of Soviet industry (machine building, power stations, building materials production, oil production, gas and textile industries) show an increase in operating efficiency of 2-25 times.

Generally, according to all available data, an increase of 2-5 times and in many instances even a 10 time increase in operating efficiency can be considered a normal result of automation. In individual instances where the adoption of automation is accompanied by the transition to new technology operating efficiency increases 30-50 times and more. Thus, for example, the automatic installation for the production of pel'meni (meat dumplings) increased the output of one worker 50 times in comparison to the formerly used manual method.

Table 6

Automatic Production Line for Machining Cylinder Blocks. Britain*

Indexes	Standard machines (prices of March 1955)	Automatic production line BMA-20266	Savings	
			Absolute	In %
1. Cost of equipment (pound sterling)	30850	25903	4947	16
2. Production area (sq ft)	500	390	110	22
3. Total engine power (H P)	127	90	37	29
4. Weekly production (pieces)	2500	3000	500	20
5. Annual machining expenses (pound st) (240 work days 8.5 hours each)	5831	1122	4709	81

Table 6 Cont'd

Indexes	Standard machines (Prices of March 1955)	Automatic production line BMA-20266	Savings	
			Absolute	In %
(a) workers' wages	3849	3238	611	16
(b) depreciation 12.5%	1542	1295	247	16
(c) repairs 5%	617	518	99	16
(d) auxiliary material 2%	371	292	79	21
(e) rent of production area 15 s per sq ft	1069	765	304	28
(f) power 1d per HP per hour	76	65	11	14
(g) insurance	1542	1295	247	16
(h) interest on the capital 5%				
Total (in pound st)	14897	8590	6307	42
6. costs of equipment per hour in pence $\frac{(b+c+d+e+f+g+j) \times 240}{240 \times 8.5}$	1066	879	187	18
7. Labor costs per hour (pence)	686	132	554	81
8. Costs of machining one block (pence)	28	$13\frac{1}{2}$	$14\frac{1}{2}$	52

(*Data from Automation. A Report on the Technical Trends and Their Impact on Management and Labour. London, 1956, pages 84-85.)

(** 1 pound sterling = 20 shillings (s); 1 shilling (s) = 12 pence (d)).

If we take into account that up to now in most instances only partial automation is mentioned, we can be certain that in the future when plants and industries become fully automated we can expect the operating efficiency to exceed the level of today's technology 100 times. A number of indirect factors indicate that such an increase is possible. For example, a fully automated concrete plant shows an increase of 10-15 times over the operating efficiency of concrete plants of the same capacity at which individual production operations have already been automated.

The drastic increase of operating efficiency resulting from automation is indicated by the following facts on the development of industry in capitalist countries. The analysis of 12 instances of automation in the USA shows an average increase of operating efficiency by 320%. At the new ammonia plant of the Spencer Chemical Co in the city of Vicksburg, USA, operating efficiency increased through automation to 2.5-3 times of the operating efficiency of other plants of the same capacity. The automated production line for machining cylinder heads at the British "AES" company increases operating efficiency 4 times. Automation of

warehousing and transportation operation in a large bakery in the USA increased operating efficiency 40 times. An automatic machine for assembling electronic devices which uses so-called printed circuits and soldering baths and which was installed at an American plant increases work productivity 100 times. A fully automated oil refinery in the USA is attended by one operator whereas at oil refineries of the usual technical level several hundred operators are still employed.

Although the increase of output per industrial worker is the obvious result of automation, it does not yet present the full concept of the economic significance of automation.

One of the most important indicators of the economic impact of automation is the decrease in the costs or production expenses. The cost is to a certain extent a total index. Subsequently we will show that cost does not cover all the types of economy achieved with automation. The extent of cost reduction in certain instances of automation in Soviet industry is shown in Table 7.

The data in the table are given only as an illustration. It proved impossible to sum up the value of cost reduction resulting from automation on the basis of the 22 examples picked at random. Nevertheless, the table does show certain characteristic features.

In the six examples which offer data on the total and processing costs, the decrease in total cost is greater than the decrease in the processing cost in one instance only (example 6).

In 12 instances the decrease of total cost fluctuates within a very wide range, namely from 1.5 to 50%. However, in 10 of the 12 instances the decrease in cost lies within the 2 to 27% range.

Thd decrease in processing costs (i.e., exclusive of the "principal and raw materials" element) in 17 examples given fluctuates within the 12 to 80% range, its average being 33.6%. Thus, the saving in the "principal and raw materials" item, as indicated by the majority of the examples, appears to be smaller than the economy in other items.

In published materials there is almost no data on the experience of industry in capitalistic countries for the determining the effect of automation on the reduction of production costs. The only known figures are the figures on the reduction of production costs in machining cylinder blocks after the introduction of an automatic productiom line at the plant of the British "Austin Motor Company" (Table 6).

In the vast majority of known instances automation drastically decreases expenses for the payment of wages (basic and extra) to industrial workers per unit produced. This is a natural result of the increase in production efficiency which, as mentioned earlier, increases 2.5 and even 10 and more times. Labor costs per unit of output are reduced on the average by 50-90%.

Table 7

Decrease of Costs Resulting From Automation, USSR (in %)*

	Reduction in total cost	Reduction in processing costs (exclusive of principle and raw material factor
1. Automation of production of rubber mixtures	1.5	50.7
2. Automation of production of synthetic ammonia	2.	12
3. Automation of the cloth bleaching process	2.3	32.2
4. Automation of beef fat rendering	2.5	20
5. Automation of sulfuric acid production	12	35
6. Complex automation of chair production connected with revision of design and technology	27.2	18.7
7. Complex automation of margerine production at the Leningrad Fat Combine	3	
8. Automation of the process of hydrogenation of fats at the Moscow Hydrogenation Plant and Rostov Fat Combine	5	
9. Complex automation of paper manufacture	6.3	
10. Complex automation of the cellulose pulping process	9.8	
11. Automated production line for manufacturing springs	17.5	
12. Mining of coal by the automatic A-2 assembly	50+	
13. Automated lines for machining "Moskvich" automobile engine block		16
14. Automated production lines for machining ZIL-150 engine block		23
15. Automated production lines for machining DT-65 engine block heads		24.5
16. Automated production line for machining single rim gears		26.6
17. Automated line for production of M-16 bolts		28
18. Automated production line for machining electric motor rods and rotors		32.8
19. Automated production line for machining the U5-M combine harvester motor block heads		36
20. Automated line for the production of M-16 nuts		37
21. Automated line for the production of chisel-type cultivating tines		50
22. Digital programmed control of 6N-13PR vertical milling machine		50
23. Automated line for the production of tractor shellboards		79.4

*Data taken from Avtomatizatsiya proizvodstva i yeye ekonomichskaya effectivnost' /Automation of Production and its Economic Impact/ by A. A. Zvorykin, Moscow, 1958, pages 39, 48; symposium "Avtomatizatsiya proizvodstvennykh protsessov" (Automation of Industrial Processes), Publishing House of the Academy of Sciences USSR, Moscow, 1956, pages 28-30, 317; symposium "Avtomatizatsiya protsessov mashninostroyeniya" (Automation of the Machine Building Processes), Publishing House of the Academy of Sciences USSR, Moscow, 1956, page 80; Materialy soveshchaniya po avtomatizatsii proizvodstvennykh protsessov v legkoy i pishchevoy promyshlennosti /Data on the Conference on the Automation of Production Processes in Light and Food Industry/, Moscow, 1956, page 82; Materialy soveshchaniya po avtomatizatsii proizvodstvennykh protsessov v tsellyulozno-bumazhnoy i gidroliznoy promyshlennosti /Data of the Conference on the Automation of Production Processes in the Cellulose-paper and Hydrolysis Industry/, Moscow, 1956, pages 24-25; Tekhnicheskiy progress v stankostroyenii /Technological Progress in Machine-tool Building/ by A. Prokopovich, Moscow, 1957, pages 111, 149, 150; "Technical-economic Effectiveness of Automatic Production Lines," by A. Vladziyevskiy in Planovoye Khozyaystvo /Planned Economy/, 1958, No 7, pages 35, 39, 40, 41.)

Thus, for example, upon studying the experience of American industry we can establish that when machining of cylinder heads became automated, expenses for the wages of industrial workers per unit produced decreased from 20 to 4 cents, i.e., by 80%. Automation of machining of one part of an army tank reduced wages costs for its production from 133 to 33 cents, i.e., by 74%. An automated production line for machining an automobile engine part decreased wage costs for this part from 5.3 to 0.3 cent, i.e., by 94%. Turning back to Table 6 we see that the automatic production line for machining cylinder blocks reduced wage costs per hour from 2 pounds 12 s 2 d to 11s, i.e., by 81%, and so on.

However, the significance of the decrease in labor costs can vary greatly in proportion to its share in the total production costs. In the example given in Table 6 the decrease in labor costs represents approximately 3/4 of the total cost reduction. However, in certain branches of industry, for example, in meat packing and dairy industries the share of wages in production costs is only about 3% on the average, in the production of iron and steel it is only 1-2%, etc. It is quite obvious that in these industries an 80-90% decrease in labor costs would reduce total costs by 1-3% only.

Moreover, automation in many instances decreases the costs of raw, capital, and auxiliary goods, power, and fuel. The experience of Soviet industry shows that automation of the production of sulfuric acid decreases pyrite consumption by 2-2.5% automation of ammonium nitrate production decreases the consumption of nitric acid by 0.5%. Complex automation of the production of alcohol affords a 1% increase in the yield of alcohol and a 5% decrease in fuel consumption.

Automation of the production of superphosphate in the superphosphate plant at Vinnitsa afforded a decrease of 0.5% in the consumption of raw

phosphate and 0.9% in the consumption of sulfuric acid. Automatic control in charging cement mills decreases power consumption by 5%, automation of the electrolytic process at an aluminum plant decreases power consumption by 1.2-1.5%. Automation of pumping stations of the water supply system in a communal farm decreased power consumption by 10-15%. Automatic control of heating and heat-treating furnaces decreased fuel consumption by 6-9%. The complex automation of cellulose pulping decreases the consumption of steam, pulpwood and chemicals by 4% etc.

We can give many more examples of decreases in the consumption of capital, raw materials and fuel resulting from automation. In most of the known instances this decrease lies within the range of a few per cent and thus is appreciably smaller in scale than the decrease in wage costs.

A significant decrease in the costs of materials, fuel, etc. is achieved, as a rule, in the instances when the adoption of automation is accompanied by the conversion to a more advanced technology. Thus, for example, the automation of the production of wieners reduces heat consumption by 2/3 and decreases losses (incurred through drying of the products) from 14 to 7%.

Automation of painting in machine building by spraying of varnish and paint in a high-tension electrical field decreases paint consumption by 20-70%. Complex automation of chair manufacture, connected with a revision of the design and technology, decreases the consumption of the auxiliary material by 18% and consumption of the principal material by 40%.

This type of economy achieved as a result of automation is especially important in such branches of industry in which the costs of raw and other materials, fuel, etc., constitute a major share of the total cost as, for example, in the food industry (share of raw and other materials -- 70-90% of total cost) or in nonferrous metallurgy (60-75%), etc.

Reduction of the amount of rejects and improvement of the quality of the product is yet another important result of automation. The principal causes of production of rejects or low quality products are either errors of the operating personnel or inadequate precision and speed of the operator's interference with the course of the process. An automatic device can control the production process and direct it without errors, without fatigue, with a precision and speed which are physically impossible for man. For example, automation of the process of reduction of titanium decreases the amount of rejects because it excludes the formation of lower chlorides of titanium, which can occur with manual control. Automation of glass founding furnaces increased the production of high grade glass from 26 to 50%. Production of high grade cellulose increased from 85 to 97% as the result of automation. Rejects caused by overburning in the soaking pits of No 3 blooming mill at the Magnitogorsk metallurgical plant decreased from 0.85 to 0.01% and in the soaking pits of the slabbing mill at the "Zaporozhstal'" Plant from 0.5 to 0.03%. The yield of the highest grade of tomato products at the Cherkasskiy Cannery increased by 10% as the result of partial automation. In certain instances in the chemical industry, nonferrous metallurgy, and a number of other industries

the increase in the yield of the highest-grade products and the most efficient utilization of the raw materials are considered to be the principal effects of automation of the industry.

In literature on economics it is often stated that automatic equipment costs more than nonautomatic and that therefore automation increases the absolute cost of equipment per unit of product. In some instances such statements are true, however, they cannot be considered absolutely correct. We can give many examples where automatic equipment costs less than the "ordinary" nonautomatic equipment. As an example, we shall give several facts from the experience of the introduction of automation in American industry (Table 8.)

There are still very few comparative analyses of the prices of automatic and nonautomatic equipment of equal capacity (or, which is essentially the same, of capital expenses per unit of production in automated and nonautomated production). Therefore, any attempt at a certain summation encounters extreme difficulties. Without doubt, in most instances the nominal price of automatic equipment today is higher than the price of nonautomatic equipment replaced by it. However, on the average, this difference is probably not very great. According to the computations performed by the American economist V. Leontieff in 1952, automation increases the capital outlay for a new installation in the chemical industry by 10%, in oil refining industry by 5-6%, in canned food industry by 3-5%, in rayon production by 1-2%, etc., and on the average, in the industry in general by 6%. When the technology of the production is not changed the difference in costs is reduced in essence to the cost of the means of automatic control and regulation and of loading and transportation devices.

Table 8

Comparison of Prices of Automatic and Nonautomatic Equipment*

	Automatic equipment		Nonautomatic equipment of the same capacity.		Economy in cost of equipment resulting from automation	
	number of machines	price in $	number of machines	price in $	$	%
Machining and assembling grenades	9	120 000	27	300 000	180 000	60
Machining cylinder heads	1	230 000	6	240 000**	10 000	4
Machining axis bushing	1	318 000	5	540 000	222 000	41
Machining a certain part of army tank	1	88 000	4	260 000	172 000	68
Assembling radiator tank		30 000		30 000 (approx.)		

*Data from The Automatic Factory; A Critical Examination, Princeton, 1956, pages 39-42, 47-48.)
**In terms of the prices of 1949. In all other instances the prices of nonautomatic equipment are those which existed in the year the automatic equipment was purchased.)

At the same time automation appreciably increases the operating efficiency of the equipment primarily through reduction of lost time and a better adherence to the optimum mode of operation for the equipment. Thus, for example, in the USSR automation increased the output of blast furnaces by 7-10% and open hearth furances by 8%, output of reverberatory furnaces in nonferrous metallurgy by 8-11%, output of soda furnaces in the production of soda ash by 22%, output of rectification columns in synthetic rubber production by 50%, output of the refining divisions in the vegetable oil production industry by 20%. Adoption of an automatic block system doubles the traffic capacity of double-track railroads. Automation of the principal assemblies of polyethylene production in the Okhtenskiy Chemical Combine increased the output of the units by 25%. Automation of sweetened condensed milk production increased the factory's capacity by 30-40%. The British engineer Macmillan claims that introduction of automation can increase efficiency by 30% owing to the reduction of idle time only.

Thus it may be considered probable that although automation increases to a certain extent the nominal costs of the equipment and thereby the capital outlay for the purchase of equipment, in most instances it reduces both the capital outlay and the depreciation costs per unit of annual output, although to a lesser extent than it decreases the labor costs. However, we must remark that this result is not a feature characteristic of automation only. The entire progress of technology is reduced essentially to the same result and automation only accelerates this process. In his analysis of the transition from manufacturing tc large machine industry Marx had already written: "A comparative analysis of the prices of handmade or manufactured goods and of the same goods produced by machines indicates, in general, that in the machinemade product the portion of the cost in terms of the means of the work increases in the relative sense but decreases in the absolute sense". (See K. Marx, Kapital, Vol 1, page 396).

We must make a passing remark on the price level of automatic equipment. Most of the examples of high expenses incurred in the introduction of automation concern equipment which had been custom made, the price of which, as a rule, includes also the cost of planning and designing. Copying the same equipment proves to be much cheaper than building the prototype. Industrial practice leads to the most rational solution of the problems connected with automation, including that of designing automated equipment which has the highest technical properties and the lowest price.

Gradual transition to the block and assembly principle in designing automation apparatus and to the use of completely unified standard units and assemblies from which various production cycles can be formed, will

shorten decisively the time required for designing automation instruments and will afford a conversion to serial and even to automatic production of automatic equipment. This will drastically reduce the cost of automatic equipment.

Moreover, automation reduces, at least in certain branches of industry, the costs in equipment repair and the number of repair crew personnel, the wear on equipment and increases the periods of time between repairs. This is explained by the fact that automation ensures the stabilization of the technological process and the uniformity in the mode of operation of the equipment, while at the same time avoiding the various errors possible with manual operation. For example, automation of open hearth furnaces at certain plants increased the length of the run by 10-15% and reduced the consumption of refractory materials on the average by 13.3%. The same is observed in the chemical industry.

The increase in the productive capacity of the equipment mentioned earlier, in conjunction with the usually smaller size of automatic equipment in comparison to nonautomatic equipment, as well as with a more efficient flow sheet resulting from automation leads to an appreciable reduction of production area (see Tables 2, 4 6). In the American literature there is an analysis of 12 instances of the introduction of automation into industry which shows that the adoption of automated equipment reduces the working area by 12-94%, on the average by 59%. The British scientist Lilli estimates the reduction of the working areas as the result of automation at approximately 25-50%.

The economy in working space permits the increase in the volume of production appreciably without erecting new buildings. Thus, for example, the introduction of more than 60 automatic lines and 150 rotary assembly automatic machines at the plant of the British "Austin Motor Company" increased the production of automobiles from 3500 to 5000 per week without construction of new buildings. Introduction of 1,500 automatic lines for the production of butter in the Soviet dairy industry will increase butter production 2-3 times without increasing the working area. Automation of 12 blast furnaces at a cost of 6,000,000 rubles will replace, through their increased productivity, the construction of one new blast furnace which would have cost 100,000,000 rubles.

We must add that automation reduces more than the costs of construction of the principal industrial buildings. In connection with the unification of separate links of the production into a single mutually related and rhythmically operating entity, costs of construction of auxiliary buildings (warehouses, storage buildings, etc.) are reduced. For example, at the Ryazan' oil refinery capital expenses for construction of tank farms and control laboratories were reduced by 11,500,000 rubles through automation. An especially great economy is produced by converting the installations to remote control, since in most instances remote control affords a reduction in the size of the industrial buildings and entirely eliminates the necessity for construction of offices, sewage systems, plumbing, etc. For example, the capital expenses for the construction of remote control operated hydroelectric stations, substations,

distributing networks, pumping stations, etc., are reduced by approximately 30% in comparison with ordinary installations of similar capacity.

Thus, automation does more than appreciably increase operating efficiency and decrease production costs in that it also results in an economy of capital outlay per unit in the annual volume of production. Investment of capital in automated industry can be generally considered as the most effective use of funds since an appreciably greater increase in the production volume is obtained per unit of capital investment than from investment in nonautomated industry.

Automation improves a number of economic indexes in the activity of enterprises. This includes, primarily, the sharp increase in the rate of capital turnover. This acceleration is based on the great reduction of production time, which in most of the known instances represents one of the most obvious results of the introduction of automation. At the Moscow Automobile Plant /imeni Likhacheva/ the automatic gas carburization installation reduced the time required for carburization of gears from 18 hours to 45 min. The automatic pencil production line installed at the pencil factory in the city of Budejovice in Czechoslovakia decreases the time required for making pencils from plank to finished product, from 14 days to 10 minutes. At the Ford plant in Cleveland, USA, introduction of automation reduced the time of production of a cylinder block from 9 hours to 15 min. Utilization of computer controlled milling machines permitted the plant to reduce the production time of extremely complicated machine parts in one instance from 3 weeks to 4 hours and in another instance from 2 weeks to 1 hour.

The shortening of the production cycle decreases the amount of half-finished products and greatly reduces the volume of industrial stockpiles. This liberates appreciable amounts of funds and at the same time reduces the current storage expenses. The British "Austin Motor Company" published a statement to the effect that as a result of automation the expenses for storage of the reserves of half finished and finished products were reduced by 2,000,000 pounds sterling (at the discount rate of 5% this represents an annual economy of 100,000 pound sterling).

Moreover, automation appreciably improves work safety and reduces the number of accidents and breakdowns. It is impossible to compute the total economy achieved in this instance; however, there is no doubt that the economic effect, especially under the conditions of the socialist system, is extremely great.

All that was said earlier on the economic effectiveness of automatic production was based on its comparison with the nonautomatic production. However, in many instances such a comparison is impossible. This pertains to such new production processes which simply could not exist without automation. Here automation is the only possible solution and its economic effectiveness is equal to the economic effectiveness of introducing the new industry as such, which, in its turn is determined by the demand of society for the new product, the feasibility of its replacement with another product, the amount of collective work used in the production of the new product, etc. Today, such industries are represented by atomic

power engineering, production of nuclear fuel, many plastics, synthetic alcohol, etc. The number of similar industries will, without doubt, increase rapidly and it appears that the principal effect of automation lies precisely in the feasibility of transition to new intensive, highly efficient production processes.

In most of the known instances the economic effect of automation greatly exceeds the effect achieved by the hitherto existing technical discoveries. This is the reason why it is adopted in almost all branches of the national economy at a rate much higher than the rates at which industry adopted technical innovations and inventions in the past.

By increasing drastically the productivity of social labor automation promises a bright future to the human society; for the first time in history prerequisites are being created for production of material wealth independently of the working time available to society. However, as it will be shown below, this future is possible only in a communist society.

Chapter II

CONSEQUENCES OF AUTOMATION UNDER CAPITALISM

(Bourgeois Apologetics and Capitalistic Reality)

The first chapter dealt with the potentialities of automation which reflect its significance in the increase of productivity of the work in society. The degree to which these potentialities can be realized depends on the social system under which automation is being put into practice. Socialism creates the conditions for a maximum rate of adoption for automation and the most efficient utilization of the gigantic possibilities it presents for the good of society. Capitalism sets definite boundaries to the adoption of automation. Periodic crises interrupt the normal course of technical progress, lead to an underemployment of the new technology already adopted and to tremendous losses of work in the society.

The more an industry is automated the greater is its demand for a constant expansion of the market with the consequent deepening of the danger of crises under capitalism. In its pursuit of profit capitalism constantly strives to decrease wages, thus narrowing the boundaries of the economically profitable application of automation. Automation increases the tendency toward monopoly in modern capitalism while monopoly, in its turn, exhibits a tendency toward the retardation of technical progress. On the other hand, competition and pursuit of profit lead to the development of the tendency toward rapid growth of technology. The process of technical development under the conditions of modern capitalism occurs during the struggle of these two opposing tendencies and therefore exhibits an irregular, staggered character.

The capitalistic method of production moves toward the introduction of automation during the final stage of its historic course, during the period of the universal crises of capitalism. Automation is a factor of the further sharp aggravation of all the contradictions between the social character of production and the capitalist system of appropriating its results, between labor and capital, between the growing potentialities of production and the limited capacity of the capitalist market.

Under the conditions of capitalism the development of automation exhibits a contradictory character and is constantly impeded by the narrow limitations of the capitalist industrial relationships. The social and economic consequences of capitalist application of automation are in conflict with the potentialities revealed by it. Below we shall examine the impact of automation on certain material aspects of the capitalistic economic system, unemployment, marketing of the products, and labor conditions.

1. Automation and the Unemployment Problem

Capitalist industrialists and their apologists, the economists, in

every way glorify the various advantages which are ostensibly brought by automation to the workers in the capitalist countries. Automation will be a "real blessing" to the working class, asserts Mr. Smith, President of the American metallurgical firm, Steel Improvement and Forge. Automation will "revolutionize the division of private property" and will "make stockholders of workers" adds Mr. Perez Coelo of Uruguay. Automation is a "Western miracle" writes the American Machinist magazine. These advertising panegyics reached their peak in the leaflet published by an American industrialists' association: "We stand at the threshold of a golden future. The working man must await it with hope and should not fear it. Automation is a magic key for the creation of values and not a crude instrument of destruction; the talents and knowledge of the workers will also receive their rewards in the coming fabulous earthly paradize. For the developing, dynamic American economy there are practically no limits ... The magic carpet of our free economy, served by the infallible tireless activity of automation, controlled by electronic devices, moves on the wings of nuclear energy forward to the undreamed of horizons. Traveling with it will be the greatest experience on earth." 1/See Note/

(/Note./1 We must remark here that this leaflet did not impress the workers as expected; among the American working class it received the sarcastic characteristic of the "magic carpet economic theory.")

Using similar publicity stunts the defenders of the capitalistic system attempt to create the impression that automation will supposedly cure all the diseases of capitalism, abolish unemployment, and result in eternal flourishing, class harmony, etc. In short, bourgeois apologetics use automation as the new starting point for their old "theories" on the "crisis free," "rejuvenated," "planned," "people's," and so on, capitalism.

The reformist "theoreticians," in joining this concert, strive to revive once more, with the aid of automation, the long-buried "theory of the gradual growing of capitalism into socialism" and assert that automation as such, without a class struggle and social revolution, is capable of creating a new welfare society. For example, the reformist theoretician Karlo Schmidt made the following statement at the Congress of the West German Social-Democratic Party in Munich: "Has our time today really created not only new but revolutionary industrial relations? I think it did. The ability to create unprecedented amounts of energy by atomic fission or fusion, the automation of many industrial processes, the electronic brain, -- these are phenomena which cannot be compared with anything which has occurred in our industrial relationships in the past. Here we witness not only changes in production methods but the spontaneous appearance of a technology unrelated to the preceding conditions, which radically changes our social order, our political forms of life, even the very forms of human existence."

The same assertion is made by another prominent member of the West German Social Democratic Party, Leo Brand: "Permit me to emphasize the principal characteristic of the second industrial revolution: it upsets society; we have entered the epoch of a profound influence of science and research through industry and production on the living conditions of

humanity throughout the world, we have entered the social phase of industrial development."

All this noisy campaign of bourgeois propaganda is aimed at lulling the alertness of the working class, at breaking its resistance to capitalistic methods and consequences of the adoption of automation, at drawing it away from its fight for socialism. However, all this publicity noise which, by the way, contains nothing new, has no visible success. Not only among the ranks of the working class but even from the direction of certain bourgeois scientists and public figures we hear, ever more frequently, warning voices expressing serious concern with respect to the consequences of adoption of automation under capitalism.

The secretary of American AFL-CIO unions, G. P. Delaney speaking before the International Labor Conference in 1956 said: "The new technology may free man from the routine and monotony of labor, but it can also deprive him of work and wages." The President of the Canadian Labor Conference Claude Jaudoin said at the International Labor Conference in 1957: "It would truly be the greatest tragedy if the great and remarkable opportunities offered by the new technological revolution would benefit only a few and cause suffering to a greater portion of production workers of the world."

The American economist V. S. Buckingham, Jr., professor of industrial organization at the Georgia Technological Institute said at the conference on automation organized by the American unions in 1955: "...all our historical experience indicates that an innovation of such dimensions as automation necessarily leads to great difficulties in our economic and social structure." Let us quote the opinion of the American mathematician, Prof Norbert Wiener, one of the founders of cybernetics: "It is absolutely clear that it (i.e., automation, Ya. A.) will cause such an unemployment problem in comparison to which even the depression of the thirties will appear to be a pleasant joke."[2] /See Note/

(/Note/[2] It is easy to understand that this point of view of a world renowned scientist is highly disagreeable to the capitalistic apologetics. Therefore, many bourgeois economists state that Wiener who is a prominent mathematician, understands nothing in economics and therefore has no business writing on problems of economics. The British vulgar economist Eintsig even accuses Wiener of being the potential cause of crises since his opinion may "lead many people to defeatism" which, according to the psychological "theory" of crises, serves as the cause of the economic crises.

The opinions quoted (many more similar ones could be adduced) belong to persons who can in no way be suspected of sympathy toward Marxism. However, even their opinions indicate that the consequences of automation for the workers in capitalistic countries will be quite different from those publicized by the capitalists and the "learned" agents of monopolies.

Adoption of automation to any significant extent began relatively recently even in the most highly developed industrial capitalistic countries. Although some individual examples of automation without doubt amaze us with the gigantic possibilities which they present, however, almost

all of these examples (with a few exceptions) represent merely the vanguard and not the social average of technology. The consequences of their adoption were manifest a year or two ago essentially on the scale of individual plants only, and to a lesser degree on the scale of individual branches of industry. At that time automation had not yet receached such a level as to make its influence manifest on the scale of the entire national economy of a certain country. Thus, the consequences of capitalistic adoption of automation must be evaluated at this time not as general summations but as separate examples only. However, these examples are highly illustrative. They show clearly that automation is a serious threat to the position of the working class of the capitalistic countries.

At a certain electrical engineering plant in England 3,000 men were employed in 1954; subsequent to partial automation the number of workers was reduced to 1,800 men; in 1956 the plant became complexly automated and as the result only 23 workmen remained there.

The British Standard Motor Company in 1956 during the preparations for the production of a new type of tractor installed 22 automatic production lines and 160 rotary semi-automatic machines at its plant in Conventry. As a result 2,500 of the 11,000 workers of tne firm lost their jobs. The strike with which the workers attempted to fight the layoff was named by the British press, "the first strike of the automation era." Incidentally, this term is not correct. "The first strike of the automation era" occurred in Canada in 1955 at the Holmes Foundry in the city of Sarnia, Ontario. The plant which makes enginer blocks for the Canadian Ford enterprises reduced the number of its workers from 480 to 280 as the result of automation, simultaneously increasing its production from 664 blocks to 900 blocks per day.

During a production slump at the end of 1953, 40,000 workers were laid off at the metallurgical plants of the American city of Pittsburgh. In 1953 steel production attained its former level. However, only 14,000 of the laid off workers received employment again. "The remaining 26,000 became chronically unemployed, displaced by automation," stated the British Times. The entire American metallurgical industry attained in 1957 the maximum 1953 level, but the number of workers was reduced by 70,000 men.

The number of workers employed in the American oil refining industry was reduced as the result of automation from 147,000 in 1948 to 137,000 in 1954 although the output of the industry during the same period of time increased by 22%. Certainly, in 1954 the over-all extent of automation in this branch of industry was still small. However, as early as 1955 an American expert speaking of the future development of automation in the oil refining industry expressed an opinion that the modern oil refinery operated by 800 workers under the condition of full automation of all the processes can attain the same output level with only 12 workers.

The development of oil refining in France exhibits a similar tendency. The number of workers employed at this work is steadily decreasing as the result of automation, whereas the output increases: instead of

35,000 men employed in 1952 only 29,000 remained by 1955, while the amount of oil refined during these years increased from 22,500,000 tons to 28,000,000 tons. Thus the 24% increase in production was accompanied by a 17% drop in employment.

In the American automotive industry in 1956 the volume of production increased 14% in comparison with 1953 while the number of employees decreased 20%. Certain surveyors are of the opinion that this branch of industry which in 1956 employed approximately 800,000 workers in the very near future will retain only 200,000 men as the result of automation.

In 1954 the number of subscribers of the telephone network of the American "Bell Telephone System" increased by 1,400,000; at the same time the number of employees of the same firm was reduced by 17,500 men as the result of automation of telephone communications. Automation proved exceptionally profitable for Bell Company; in 1954 each worker began to give the company $961 profit instead of the $420 squeezed out of him in 1946. The President of the American Union of Communication Workers is of the opinion that by 1965 the total number of the workers of the Bell Company will be decreased by 100,000 - 115,000 more men.

The American magazine "Automatic Control" assumes that were the automation of the American industry to attain its maximum development, the proportion of laid off workers would attain a ratio of 100:1.

Practically not one of the authors who write on automation in the capitalistic countries has any doubts that its adoption sharply increases labor productivity and thus potentially replaces a large number of workers. An essential difference in opinion arises among these authors only when they are faced with the question: will this potential replacement of a large number of workers turn into an actual unemployment on a gigantic scale?3 /See Note/

(/Note/3 In this respect it is quite characteristic that many of the papers on automation published in capitalistic countries bear the title: "Automation, Friend or Foe?", "Automation, Dream or Nightmare?", "Automation, Blessing or Curse?", etc.)

Many bourgeois economists, for example, admit that automation results in laying off of workers in some branches of industry but, in the opinion of these economists, the laid off workers will soon find employment at the plants producing the means of automation. In this manner they reduce the entire problem to the correct preparatory organization of the transfer of the discharged workers to new branches of industry.

Let us disregard the fact that the transfer of workers from one branch of industry to another is in no way an organizational problem only. As to the production of the means of automation, we admist that until the present time it has been developing in all leading industrial countries at a rapid rate. However, firstly, this development proceeds at the expense of the transition of the production of "ordinary"equipment to the production of automatic equipment, i.e., simply at the expense of the replacement of the production program and therefore has no effect on the increase of the number of employees; and secondly, automation is being introduced today and without doubt will be introduced in the future even

on a greater scale, into the production of the means of automation itself. Hence there is no direct relationship between the increase in the production of automatic equipment and the increase in the employment in this branch of industry.

James Cary, President of the American Electrical Engineering, Radio Engineering and Machine Building Workers Union and Secretary of the AFL-CIO, in his speech before the Congressional Subcommittee investigating the problems of automation in the USA stated the following: "You have already heard much about the electrical industry which produces automatic equipment. You have been told that these branches of industry doubled their volume of production and will double it again in the coming years. You were also told that the electrical industry will develop so rapidly that it will absorb the workers which have lost their jobs in other industries. Unfortunately I must tell you that these statements are a mixture of partial truths and nonsense." Cary mentioned many facts of which the most interesting and convincing ones consist of the data on the production dynamics, profits, and employment conditions of the American Westinghouse Electric Company, one of the leaders in the field of electrical industry in the years when automation made its first strides in this industry.

Table 9

Years	Production (thousand $)	Net profit (Thousand $)	Total number of employees (men)
1954	1 631 045	84 594	117 143
1953	1 582 047	74 323	122 729
Total	+ 48 998	+10 271	- 5 586

Thus the growth of production volume during these years was accompanied by the reduction of the total number of employees. Subsequently, a recession in the USA brought about a drastic reduction in the production volume of the electrical industry. Although in September 1957 the index of production volume of this branch of industry reached 220 points (1947-1949 = 100), in May 1958 it was already reduced to 160, i.e., became 27% lower than in September 1957 and 15% lower than in the first half of 1955. As the result the number of industrial workers in the electrical industry in May 1958 fell to 159,000 less than in September 1957 and 85,600 less than in the first half of 1955. When in November 1958 the index of production volume in this branch of industry had again risen to 200 points exceeding the level of the first half of 1955 by 6%, the number of industrial workers did not increase in the same proportion but was 31,000 or 4% less than in the first half of 1955.

Thus the argument of bourgeois apologetics which claims that workers discharged as the result of automation will find employment in the production of means of automation proves to be incorrect both during

the period of industrial rise and even more so during the time of a crisis.

We can also prove by the purely logical method of a simple mathematical calculation that this argument is not correct. Let us assume that an industrialist will buy a machine for $120,000 and it will do the work of 24 workmen whose yearly wages are equal to the price of this machine. Consequently, the yearly wages of one workman is $5,000. In the opinion of bourgeois economists 24 workers must again find employment in the production of the machine which replaced the work of 24 workers. However, the price of the machine does not represent the workmen's wages only. It also includes the price of the means of production necessary for building the machine and the surplus value. Let us assume that the price of the machine ($120,000) represents $80,000 c +$20,000 v + $20,000 t. At the same yearly wages ($5,000) only 4 men will be employed in building the machine which replaces the work of 24 men. This example, of course, is greatly simplified. Without even mentioning the fact that the rate of surplus value in reality is probably much higher than in the example; that the useful life of the machine in actual practice is usually longer than one year whereas the time needed for its building is less than one year, the main simplification lies in the fact that in the example the price of the machine is equal to the saving in labor cost. However, we must bear in mind that as it was correctly noted by Karlo Schmidt "the economy does not lower production costs in order to create thereby new production costs."

The argument examined above of the contemporary bourgeois economists is merely a new version of the vulgar "compensation theory" which was brilliantly smashed by Marx almost a hundred years ago. It is not worth our while to spend much energy in fighting this "theory", especially as the bourgeois economic science uses it frequently but rather cautiously in the form of one of its arguments. We must only bear in mind that certain authors (for example, Karlo Schmidt, Walter Reuther) who attempt to refute this argument of bourgeois economics, in fact accept its incorrect theoretical foundation. They assert that if the workers discharged as the result of automation were employed in the production of the means of automation this fact would mean only that one item of the calculation, namely, "labor costs" would reappear under another term, namely, "equipment costs" and therefore there would be no reduction in total costs of production. This is incorrect since the cost of the machine includes more than the workmen's wages.

Another argument of the bourgeois economists against the possibility of unemployment due to automation consists of the claim that the development of technology lowers the prices, thereby increasing the demand and creates new branches of industry thereby increasing employment. The capitalistic economy, assert the bourgeois economists, had always "adapted itself" to the development of technology, it will "adapt itself" this time also. It is easily noted that here the commonplace dogmas of the vulgar political economy of the 19th century appears in a slightly rejuvenated form; in this instance it is the market theory of J. B. Say with its "metaphysical equilibrium of sellers and buyers" and N. W. Senior's "principle of the growing productivity of industry." Marxism has long ago revealed the apologetic and anti-scientific nature of these "theories."

This argument is regarded with a scepticism even in the contemporary bourgeois literature.

Firstly, although capitalistic economy had until now always "adapted itself" to the development of technology, this "adaptation" was always accompanied by economic crises and a sharp increase in unemployment. Under the present conditions the extent of the possible increase of unemployment represents a deadly peril to the very existence of capitalism or, using the expressions of bourgeois economics and sociology, can bring about the "destruction of our entire civilization," is a "threat to the very life of society" and "downfall of the established social order."

Secondly, even though until the present time every type of development in technology had in the end brought about an increase in the total number of employees, this does not yet signify that automation will lead to the same consequences. Automation is adopted at a much more rapid rate than any preceding technological innovation. It concerns to some extent all the branches of the national economy, whereas formerly technical development occurred mainly in certain individual branches of industry. And lastly, automation increases labor productivity on an unheard of scale. Therefore, in the words of the American Democratic Senator O'Mahony "no one can know if this type of technical development (meaning automation) will create a sufficient number of employment possibilities to offset those that it will remove."

Certain bourgeois authors working in the field of automation are employing various combinations of the two above mentioned arguments in order to deny the existence of a threat of colossal unemployment. One of the most vulgar representatives of the modern vulgar economy, the British economist Eintsig in order to affirm his position gives both the argument on the growth of the production of automatic equipment and the argument of new branches of industry called to life by automation. However, in his opinion "it would be unwise to overestimate these possibilities for employment in new branches of industry and to assume that their growth will be sufficient to cover dismissals from the old branches of industry." Therefore, Eintsig offers additional possibilities for workers who lose employment because of automation:

1) "Demand for artists of every kind will grow;"
2) Workers who had lost employment in cities can go to work in agriculture;
3) Women can simply stay home as housewives;
4) All unemployed can emigrate from England.

Other bourgeois authors admit that automation will bring great hardships and unemployment in a number of branches in industry. However, in doing this they state that this would be only "short-term derangement," "hardships of a transitional character," "passing sacrifices in the interests of over-all progress" and that the long-term results of automation will be universal well-being and a heaven on earth. These demagogic statements have no value whatsoever. Promises of universal welfare in the distant future which must be bought by transitionary sacrifices remind one of the deliberations of the church people on heavenly paradise which one can enter through humility, patience, and suffering on earth.

Life refutes the proofs of the apologists of the capitalist forms on the adoption of automation. The bourgeois authors themselves point to the unreliability of these arguments. For example, the West German sociologist Friedrich Pollock writes: "Even were it possible to prove that technical unemployment will in the long run be compensated by the automatic reaction of the market, ... even were it possible to bring forth such a theoretical proof it will not have any practical sense under the present conditions of relationship between the forces within the society...The mass unemployment which existed at the beginning of the thirties in the United States was the last event during which those hit by unemployment or those living under its threat were still willing to wait without noticeable resistance for the time when at last the laws of supply and demand will again eliminate their poverty." Pollock's point of view has of course a sound foundation.

We can point to still another frequently encountered argument presented by bourgeois economists in favor of the assertion that automation under the capitalistic conditions will not result in mass unemployment. It is formulated in approximately the following terms: in many branches of industry, for example, in oil refining, the chemical industry, in metallurgy, in the food industry, in the paper industry, etc., labor costs constitute only an insignificant portion of production costs, a total of only 1-4%. In the course of further development in technology the number of such branches of industry will rapidly increase. Reduction of the number of workers in these branches can result only in an insignificant economy which cannot cover the costs of automatic equipment. Here the purpose of automation is not the replacement of man with machine but the improvement of the quality of the products, the optimum utilization of the raw materials, the productive capacities, etc. Dismissal of workers resulting from automation is therefore only a temporary phenomenon pertaining only to some of the branches of industry.

Beyond any doubt, in certain branches the saving in labor costs is only consequential from the point of view of the production costs. This was discussed in greater detail in the first chapter of this book. This, however, does not signify that mass dismissals do not occur upon the introduction of automation. In these branches the decrease of the number of workers is merely a consequential effect of automation and not a principal one; this fact does not reduce the threat of unemployment.

Lastly, it is often asserted that the concern about mass unemployment is greatly exaggerated because automation has an immediate effect only on some of the workers. The report of the American Congressional Subcommittee, for example, states: "Even if the extent of automation resulting from the progress of modern science could easily exceed the limits of our present imagination, it must be noted that this will not affect all the workers but in reality only a relatively small, although significant portion of the working population."

It is true that automation does not directly affect lawyers, salesmen, actors, bus drivers, public health, school, science, and cultural workers or the army. All this is generally known and raises no doubts. However, the members of the American Congressional Subcommittee in

emphasizing this self-evident fact are attempting thereby to distract the attention of society from another, no less self-evident fact, namely, that the capitalist form of using automation brings with it an immediate and real threat of mass unemployment for the working class and for an appreciable portion of the management.

Of course, unemployment is the result of social conditions under which automation is being adopted. The fact that automation results in a drastic decrease in the number of workers required for a certain operation is a progressive phenomenon. In principle, automation either replaces potential workers or displaces the actual workers, i.e., it either creates the possibility of a sharp increase in the production volume regardless of the amount of working time available to society or it leads to unemployment on a gigantic scale.

While automation on an individual plant drastically increases work productivity, it reduces the working force by a certain number of workers. In order that the laid off workers be kept from becoming unemployed and at the same time in order that the increase in operating efficiency of an individual plant be also the increase in the productivity of the work of society as a whole, it is necessary to either increase proportionally the production of the automated plant or transfer the workers who had lost their jobs to other plants in the same or other branches of industry. This means that if society strives to prevent unemployment it should constantly observe correct relationships between the use of automation, the development of production, the reduction of working hours, etc. Without this, automation will inevitably result in over-production and unemployment on a scale which is incomparable with anything which has occurred in the past. However, in order to plan the growth of production, the adoption of automation, and the distribution of labor resources, a social planning of the entire national economy is necessary, and this is possible only under the system of public ownership of means of production, i.e., under socialism.

Under capitalism where private ownership of the means of production predominates there is no direct relationship between the development of automation and growth of production. The motives which guide an individual industrialist in introducing automation have no relationship to the possibilities for the growth of production in other branches of the national economy, to the potential increase in the production of other plants of the same branch of industry, or, within certain limitations, to the potential increase of production at the very plant at which automation is being introduced. It is not even worth speaking of the fact that the capitalist does not adopt automation in order to create conditions suitable for a reduction of the working time established by law. Under capitalism the purpose of introducing automation is an increase in profit. And since this purpose can in most instances be achieved by the simplest and most rapid means through savings in variable capital, the capitalist in adopting automation strives primarily to reduce labor costs, i.e., to dismiss the workers.[3] /See Note/

(/Note/3 Even the American Congressional Subcommittee in its report on the consequences of automation deemed it necessary to include several rebukes in the direction of the industrialists: "The industrialists who concentrate on decreasing production costs forget too easily that should automated production signify increasingly small work possibilities and be adopted in spite of hardships and privations, it will in the end harm the foundation of our free society.. The Subcommittee has unfortunately established the fact that certain persons engaged in perfecting the technical aspects of labor saving machines have as yet not understood the effect of their actions on the national economy.")

This is quite openly discussed by many bourgeois authors. For example, P. Bessiet of the French firm Renault states: "Reduction of labor costs is the principal expected economy..." The Swiss economist Knecht writes the following on the same subject: "When the additional expenses for interest, depreciation, servicing, and repairs of automatic equipment are lower than wages saved by this equipment, then the automatic equipment is considered economically profitable from the point of view of expenses of the firm." The American sociologists Faunce and Sheppard express the same views: "The practical sense of the adoption of automated machines is the fact that they significantly decrease labor costs per unit of production."

The practical realization of these views is encountered at every step under capitalism. Let us examine, for example, the above mentioned experience of automation in the plant of the British Standard Motor Company in Coventry. The decision to introduce automation on a relatively wide scale into the production of tractors was made under the pressure of foreign competition in order to reduce production costs by lowering labor costs. In order to prevent the workers from losing their jobs as the result of automation the firm should have appreciably increased the production of tractors or transfer the workers to the firm's other plants, namely, the automobile plant which in this instance should have been expanded. However, the state of the market did not warrant any appreciable increase in tractor production; as for the production of automobiles, it has even somewhat decreased at that time. The result had already been mentioned: of the 11,000 workers of the firm 2,500 lost their jobs[4] /See Note/

(/Note/4 A. S. Dick, one of the Directors of the firm made the following statement on the subject: "We do not introduce 4,000,000 pounds' worth of equipment so as to keep the same number of men on the job in the future. We cannot employ men just for fun.")

Thus, under capitalism the automation decreases the dependence of the production of social wealth on the amount of working time available to society, and thereby "liberates" the workers from wages and means of subsistence. The British scientist Magnus Pike formulated the essence of the problem in the following manner: "In the USA where automation is more advanced than in Great Britain the gradually increasing liberation from the necessity of working for wages is termed "technical unemployment."

Pike must be corrected only on a single point: the term "technical unemployment" originated even prior to automation. The bourgeois economics literature attempted to relegate the responsibility for unemployment on technical progress also. However, the very existence of the term quite obviously indicates the end to which the development of technology leads under capitalism. In this respect automation does not create any new problems. It only multiplies many times and aggravates the old problems and contradictions of capitalism.

Naturally, under capitalism the adoption of automation does not necessarily lead to unemployment in all instances. Automation at a newly built plant even results in a spontaneous increase of the number of workmen employed, only to a lesser extent than the increase would have been were the new plant equipped "traditionally." Automation of an existing plant combined with a proportionally increased production results in an increase of the plant's output with the same number of workers. Such facts do take place and the bourgeois economists very frequently use them in order to prove that allegedly automation under capitalism does not lead to unemployment. It is quite true that under capitalism the adoption of automation can sometimes coincide with a proportional increase in production, however, such a coincidence is purely accidental and represents only an exception to the general rule. To the contrary, automation under capitalism increases the danger of unemployment not only at the plant at which it is being introduced but at other non-automated plants of the same or associated industry which cannot compete with automated establishments.

Thus automation represents a grave threat to the workers in capitalistic countries. No one among the working class doubts this today. The working class of the capitalistic countries is preparing for the fight against the consequences of the introduction of automation. It is precisely because of this that during the recent years the bourgeoisie, with the aid of every type of "experts" has raised a deafening campaign with the purpose of confusing the issue, of concealing the extent and potential power of automation, disorienting the working class, and pacifying the popular opinion. When the publicity campaign which is attempting to exhibit automation under capitalism as a "western miracle" and a "golden age" could not convince anyone, the bourgeois propaganda began to assert that automation in essence does not exist, and even if it does exist it has no serious significance. This reveals the class essence of all attempts at denial of the fact that automation is a new phenomenon.

Automation is simply the "synonym of advanced mechanization," states, for example, the economist Eintsig. "Automation began on the day man invented the wheel," -- this "historical foundation" is provided for the concept by the American industrialist Smith. Automation is simply a new, bad word, "simply a matter of semantics," continues another American industrialist M. Hollengreen, Chairman of the Machine Builders Association. The final step in this direction is the instruction of the American firm General Motors in which the workers and employees are forbidden to use such a "dirty word" as automation.

The tricks frequently used by the bourgeois propaganda in order to prove the nonexistence of automation are illustrated by the discourse of the French official A. E. Bohardi. This statesman had first cleverly prepared the ground for his "scientific proof;" he narrowed down the meaning of the word "automation" and identified it with the so-called feedback principle. The rest was simple. Bohardi used as an example the automatic production line for the complex machining of engine blocks at the Ford plants in Cleveland. 98 operations are performed on this line. Only one of them uses the feedback principle and four operations are still manually performed. Thus Bohardi easily "proved" that on the production line which is generally considered as one of the best examples of automation in American automobile building, four operations are performed manually and only one is truly automatic. Therefrom it was easy to draw the conclusion that, firstly, automation represents only separate little islands in the entire chain of the production process and such islands of automation have existed actually for quite some time and, secondly, that the phenomenon usually termed automation is only a higher stage of mechanization.

A spirit of calm and consolation emanates from the words of Walter Puki. Automation will not manifest a grave effect on over-all employment, he says, because for a long time to come non-automated factories will exist side by side with the automated ones in the same manner as in the past "home and factory industries existed side by side" for many generations. However, to the workers these words are not very comforting. It is well known at what price the home industry system could compete with big industry and how monstrous was the position of the working class in the branches of industry which employed work in the home.

"At the present time the interest is concentrated on possible unemployment caused by automation; but this probably will not be a serious problem if automation will not be adopted at too rapid a rate..., if individual firms will dismiss only a minimum number of workers..., and if the conditions of full employment will continue so that the dismissed workers can quickly find jobs again," asserts the semi-official book of the British government (See: Automation. A Report on the Technical Trends and their Impact on Management and Labor, London, 1956, page 81). Of course, we cannot but agree that if automation will be adopted on a small scale then its consequences will also be small, if the firms will not dismiss the workers then there will be no unemployment. However, these are only ifs...

A whole book could be composed of deliberations of such nature.

It is obviously not necessary to convince the reader that the capitalists themselves understand perfectly well the significance of automation and do not consider it to be only a "bad" word. The tremendous potentialities of automation are clear to them as the speed of its expansion under the pressure of competition is obvious. Thus, in one of the pamphlets published by the American General Electric Corporation it is written: "The industrialist must automate if he wants to remain alive..." The capitalists entertain no doubts that automation under capitalism will result

in an increase of unemployment. To the contrary, they even consider it to be one of the advantages of automation. One of the directors of a major American firm states that "automation is any operation which removes man from production. However, do not use this expression."

It goes without saying that today the bourgeoisie does not favor mass unemployment. It knows very well that such unemployment might lead to catastrophic consequences for capitalism in general. Its ideal is a "moderate"unemployment, an unemployment "within certain limits," one too small to create a threat to the capitalistic system but at the same time large enough to break the resistence of the working class to the increasing exploitation. The British Confederation of Industrialists has even established the exact extent of its ideal in this respect: in its opinion the British industry would be "more healthy" if a "moderate" number of unemployed attaining 3 or 4% of the working population, i.e., approximately 750,000 persons, existed in Britain.

Thus, in the hands of capitalistic industrialists automation becomes a weapon against the labor movement. The British economist Eintsig, with the cynicism characteristic of him, frankly expresses the bourgeois point of view on the consequences of the adoption of automation under capitalism: "...The replacement of man by machine will lead to a weakening of the bargaining power of labor unions which had been artificially increased through the postwar manpower shortage." "Manpower shortage" or "overemployment" (another term used by Eintsig)[5] /See Note/ allegedly caused the workers to become lazy and now "they do not have the stimulus for keeping up a high efficiency," "discipline in industry has decreased," "many irresponsible strikes" are observed... "In lowering overemployment automation can at the same time help in renewing discipline in industry and in limiting irresponsible strikes." After hearing such arguments one is not surprised when Eintsig decisively declines all demands of the working class for better unemployment insurance, under the pretext that it would retard the development of automation.

(/Note/[5] It is well known that "full employment", "over-employment," etc., in the terminology of bourgeois economics do not signify an absence of unemployment but, to the contrary, assume the existence of a number of unemployed necessary for the needs of the capital. In 1955 when the bourgeois economists of all industrially developed countries were shouting about "full" and "over-" employment according to the data of the International Labor Bureau there were 243,000 unemployed in Britain, 158,000 in France, 928,000 in the Federal Republic of Germany, 2,654,000 in the USA, etc.

As it has been mentioned above the consequences of capitalist use of automation have until the recent times manifested only a potential threat to the position of the working class. At that time automation had not yet developed to such an extent as to make its effect felt on the national economy scale in any particular capitalistic country.

Recently, however, the situation has drastically changed. The United States where automation has advanced appreciably further than in other capitalistic countries, has finally entered a period when the

consequences of automation are felt on a nationwide basis and are beginning to affect the general balance of national economy. The American press is sounding the alarm: the consequences of automation for the working class are not merely a potential danger but a real disaster, the existence of which is recognized even by the most ardent defender of capital's interests, the bourgeois press.

"In certain branches of the process industry such technical improvements as automation -- employment of electronic brains for controlling the mechanical muscles -- reduces the demand for manpower," notes the New York Times in one of its January 1959 issues.

"Operational efficiency has again grown dramatically...The operational efficiency explosion also affects the prospects of employment...The profit margin is increasing..." states Fortune Magazine.

After the slump in production due to the recession of 1958 the American industry has generally risen to its previous level at the beginning of 1959. The industrial production index in the USA in February 1959 attained 145 points (1947-1949 = 100) surpassing the mean annual level of 1956 and 1957 by two points. At the same time the number of unemployed according to official data rose to 4,700,000 persons; in comparison to the 1957 level the number of unemployed increased by 1,800,000 or 62%. We must add that the official data on unemployment is appreciably understated: Albert Fitzgerald, the representative of the American Electrical, Radio, and Machine Building Workers Union appraised the number of unemployed in the USA during the first months of 1959 at 7,000,000.

Table 10

Changes in the Employment of Industrial Workers and Volume of Production in Certain Branches of the Process Industry of the USA*

Branches	January 1957	January 1959	Difference
Metal-working industry (exclusive of machine building)			
1. Production index	136	137**	+ 1
2. Number of industrial workers (in thousands)	904	825	- 79
Instrument building industry			
1. Production index	173	176	+ 3
2. No. of workers	231	208	- 23
Chemical industry			
1. Production index	184	197	+ 13
2. No. of workers	549	513	- 36

Table 10 Cont'd

Branches	January 1957	January 1959	Difference
Oil refining industry			
1. Production index	160	161	+ 1
2. No. of workers	133	118	- 15
Woodworking industry			
1. Production index	104	113	+ 9
2. No. of workers	594	546	- 48
Furniture industry			
1. Production index	118	131	+ 13
2. No. of workers	312	312	-
Rubber industry			
1. Production index	147	151	+ 4
2. No. of workers	216	199	- 17
Textile industry			
1. Production index	101	108	+ 7
2. No. of workers	935	855	- 80
Sewing and knitting industry			
1. Production index	113	120	+ 7
2. No. of workers	1,076	1,052	- 24
Paper industry			
1. Production index	157	166	+ 9
2. No. of workers	468	441	- 27
Printing industry			
1. Production index	136	139	+ 3
2. No. of workers	557	543	- 14
Food industry			
1. Production index	101	107	+ 6
2. No. of workers	1,015	951	- 64
Tobacco industry			
1. Production index	110	121	+ 11
2. No. of workers	88	79	- 9

(*Data from: Survey of Current Business, January 1958, March 1959, Production index of 1947-49 = 100.)

(**February 1959.)

The consequences of automation become even more obvious in the analysis of the curve of the production volume and employment of industrial workers in certain branches of the manufacturing industry.

In January 1958 during a grave slump in industrial production (industrial production index = 132) only 45 of the 149 major industrial regions of the USA had more than 6% employed. In January 1959, however, although the index of industrial production attained 143 the number of industrial regions with a greater than 6% unemployment increased to 76.

There is no doubt as to what causes production and employment to move in opposite directions: it is automation. Enormous amounts of capital invested by American industry in construction of new, highly automated plants and in radical technical reconstruction of the working plants beginning with 1955-1956 were, in general, completed during 1958. The slump in production caused by the recession induced the large firms to close the obsolete plants and concentrate production in technically advanced factories. As the result, the share of automation in American industry increased during a relatively short period of time.

"A combination of automation, constantly developing technology, and the recession of 1957-1958 brought up an immediate national problem in the continuously high level of unemployment which in most cases persisted for long periods of time," states the article "The Road to Misfortune" published in the American union magazine AFL-CIO News."

Automation continues readily in all capitalistic countries. The cause is simple: in actual practice automation proved to be exceedingly profitable to the industrialists. For example, the large firm Westinghouse Electric in 1958 sold 5.6% less goods than in 1957 and dismissed 16,000 workers. However, the net profit of the company exceeded the 1957 level by 2.9%. There are many similar examples. The entire American press is talking of the fact that profits increase simultaneously with the reduction of employment. An enormous volume of profits is expected in 1959: the US Department of the Treasury estimates it at $47-48 billion, according to other data it will be $50 billion (the postwar "record" volume of profits occurred in 1956 and attained $45 billion).

This is the"real blessing" and "fabulous earthly paradise" created for the working class by automation under capitalism.

2. Automation and the Market Problem

In July 1958 at the session of the French Economic Council, a paper was read on the economic and social consequences of automation. Its author, a union official Pierre Lienard stated: "Automation required planning...Only planning can preclude drastic economic upheavals, oversaturation of markets, emergence of an impoverished social stratum." The same thoughts were expressed by Karlo Schmidt in his lecture on the "second

industrial revolution" delivered by him at the convention of West-German Social Democratic Party: "It is necessary to plan ahead in order to avoid making the arrival of the second industrial revolution a road to Calvary for millions of people..." Similar conclusions were reached by many political and trade-union figures in Britain, USA, and other countries.

In one sense these conclusions are definitely correct: automation requires planning of the national economy. The unprecedented rate in the increase of labor productivity resulting from automation poses before the society the acute problem of constant maintenance of equilibrium in the national economy, primarily of the principal ratio of reproduction -- the ratio between production and consumption. However, the solution to this problem is entirely incompatible with the capitalistic ownership of the means of production and on this subject the bourgeois partisans of economic "planning" are silent in an attempt to create reformist illusions in the working class.

The capitalistic system is unable to plan the national economy, and it cannot prevent the increase of unemployment. Similarly, this system cannot solve the problem of the market, and ensure the balanced ratio between production and consumption. Just as all the assurances that capitalism "ensures employment" are reduced at best to an increase in unemployment insurance and an improvement of the activity of employment agencies, in the same manner all that remains from the loud words on "planning" of capitalistic economy is a good sales manager and a more inventive advertising department manager. Better salesmen, better advertising, fiercer competition, such is the capitalistic "solution" of the market problem.

In this respect the words of the British engineer Sargrove spoken at the International Congress of Cybernetics held in June 1956 in Belgium, are quite characteristic. Sargrove concluded his report on the automated plant for the production of radio receivers, which for twelve years could not attain its full output capacity due to an insufficient market, with the following words: "You can see in our example that prior to building automated factories we must ensure stable markets and obtain a good sales manager." The American economist Druker stated that automation of production requires a revolution in sales methods.

Certain bourgeois authors express the hope that automation of office operations, use of electric computers which afford a rapid analysis of the state and trends in the markets will ensure the "regularity" of production and will eliminate the threat of overproduction crises. These machines are truly outstanding achievements of technology. They will probably create a veritable revolution in the methods and forms of office work. However, all such machines in addition to an appreciable lowering of administrative costs, only yield a more prompt, extensive, and correct information on production, supplies, prices, etc. No matter how perfect the machine, it cannot affect economic laws and eliminate the subordination of capitalistic economy to the anarchy of the market.

It is obvious that the most brilliant advertising, the best salesmen, and the most cunning automatic machines cannot free capitalism from its contradictions. Nor can they help capitalism in the solution of the market problem.

This problem was not posed by the advent of automation. Together with the problem of unemployment, it is not new to capitalism. The essence of it lies in the fact that automation, by a maximum aggravation of antagonistic contradictions of capitalism renders the problem of the market many times more complex.

As it was shown earlier, automation sharply increases work productivity. From this ensue two abstract theoretical possibilities. 1) If the production level does not rise at all, or rises to a lesser degree than does the operating efficiency, the result is a gigantic increase in unemployment, a sharp slump in the purchasing power of the population and, consequently, a disturbance of the ratio between production and demand, i.e., a market problem. 2) If the production level rises in proportion to the increase in operating efficiency (or, more precisely, outstrips it, since we must also take into account the increase in population), in this instance, although no unemployment occurs not considering the possibility of reduction of the work week, changes in the ratio of the workers in production and the non-production fields, etc.), the necessity arises for a corresponding increase in the purchasing capacity of the population, i.e., the problem of the market arises again.

This purely abstract discussion helps clarify the fact that in all instances of automation under capitalism the market problem is always present. As it was stated by the American union man James Cary: "The rapid technological progress and the resulting rapid growth of operating efficiency must be accompanied by a rapid increase of the consumer's purchasing capacity. Only when the purchasing capacity of the population is high enough to buy the increasing amount of goods and services which the new technology puts at our disposal shall we be able to keep up a high level of employment on a national scale. The alternative is a growing unemployment... However, there is no guarantee whatever that the monetary demand of the masses of consumers will grow sufficiently to absorb the rapidly increasing volume of production."

In the industrial capitalistic countries the adoption of automation was until now usually accompanied by an increase in production volume and to an appreciably greater extent by an increase in industrial capacities. It was shown earlier that the growth of production volume was, as a rule, appreciably smaller than the growth of operation efficiency resulting from automation. In this connection the number of workers in the sectors in which automation was adopted has been drastically reduced.

The increase in the volume of production in firms which were introducing automation was caused, on the one hand, by the favorable state of affairs which existed in the capitalistic countries until approximately the second half of 1957. On the other hand, automation itself has a powerful effect on the growth of production or, using a better expression, on the increase of production capacities. There are many factors which produce this effect.

First, the economic effectiveness of automation is as a rule greater in such instances when its introduction is combined with an increase in productive capacity. In instances when the purpose of automation is the modernization of the existing equipment only, this often brings about

a premature depreciation of the existing equipment and an increase in the depreciation deductions. Both of these factors cause an increase in the cost of automation and a decrease in the economy achieved through the use of automated equipment.

Secondly, automation appreciably decreases the idle time of the equipment, makes it possible to conduct the technological process under optimum conditions, and thus increases the useful capacity of the equipment.

Thirdly, the manufacturer who has adopted automation and thus outstripped his competitors, strives to use this advantage to increase his share in the market.

Fourthly, automation exhibits a tendency for an absolute reduction of equipment costs per unit of production although in most instances the automatic machine costs more than a machine that is not automatic. The decrease in equipment costs per unit of production is achieved because the efficiency of an automatic machine as a rule increases more than its cost. Therefore, the limit of minimum production volume below which a new machine becomes economically unprofitable is inevitably lowered in connection with automation.

Fifthly, many new automatic machines have a tremendous productive capacity which is incomparably greater than the capacity of hitherto existing equipment. As a highly illustrative example we can mention the so-called belt machine producing bulbs for incandescent lamps, which was designed by the engineers of the American Corning Glass Works. The capacity of the machine is 1,800 bulbs per minute or more than 2,500,000 pieces per day. One of the Corning Glass plants which has 14 such machines, each attended by only one operator, produces 90% of all bulbs for incandescent lamps used in the USA.

The tendency toward a sharp increase in production volume is thus included in the very essence of automation. The opinion of certain observers in the capitalistic countries is that "in many branches of industry the capacity of the market is insufficient to justify the conversion to automation of any more plants producing the same commodity."

Under the conditions of the capitalistic method of production subject to the anarchy of the market, automation exercises a strong influence on the creation of excess productive capacities and aggravates the danger of overproduction to a maximum. This can be illustrated with the example of the American automotive industry. Automobile production is one of the most highly automated of American industries. Here automation covers every phase of production. As the result of the high concentration the share of automated production in the total volume of production in this branch of industry is probably higher than in other branches of American industry.

During the 1954-1956 period all the major American automobile companies introduced automation on a wide scale. In doing this every one of them hurriedly increased its productive capacities in order to outstrip its competitors and to increase its share of the market. This competitive race resulted in excessive production capacities and overproduction on a large scale. Sales difficulties which began to develop

during 1956 grew into a grave overproduction crisis in the second half of 1957. The index of automobile production (1947-1949 = 100) in December 1956 was 143, in October 1957 it decreased to 126, in April 1958 to 86; in October 1958 it was equal to 91. In the period from February to October 1958 automobile production in the USA did not even rise to the 1957-1949 level and was more than one third lower than in December 1956.

Here we must make a remark. Many economists perceive new aspects of the sales problem in the fact that automated industry "loses flexibility" owing to the difficulty in resetting the equipment and therefore cannot adapt itself in time to the demands of the market.

This point of view is certainly well taken; "the loss of flexibility" today has great significance in the practice of adoption of automation and its impact on the sales problem should not be underestimated. However, as it had been demonstrated earlier the loss of flexibility is only a temporary factor. Even today it is not inevitable in automation and in the future it will probably be overcome completely. An extensive adoption of automation will become technically and economically feasible even in such branches of industry in which frequent changes of production program are necessary.

We must note, however, that this trend in the development of automation technology which is immensely significant for the prospects of adoption of automation in the future does not change the effect that automation has on the increase of the production volume. For example, the equipment of a fully automated concrete plant of the American Cleveland Builder Supply Company exhibits great flexibility; it can produce up to 1,500 different types of concrete and the production program is simply and rapidly changed by means of punched cards inserted into the controlling device. All this, obviously, does not reduce the production volume. To the contrary, the capacity of the plant attains 200 cubic meters per hour and consequently, the plant can operate only in areas where large scale construction exists.

Under capitalism the reason for introducing of automation, as well as of capitalistic industry in general, is the increase of profits. The correct ratio between production and consumption here is attained only spontaneously, as the result of periodically occurring crises. Under capitalism equilibrium is only incidental during continuous inequilibrium. We may say that the capitalist economic system is in terms of automatic technology, extremely "unstable" and the adoption of automation increases this instability to a maximum.

Certain bourgeois authors assert, to the contrary, that the adoption of automation will have a "stabilizing effect" on the capitalistic economy. These authors use essentially the following two arguments. Firstly, automation changes sharply the value structure of capital. While on the average there is $9,200 worth of machines and equipment per industrial worker in the American machine building industry, on the highly automated Ford plant at Cleveland this sum attains $28,750. Thus the share of wages in the cost structure decreases drastically and the share of depreciation deductions increases. Hence, the conclusion is drawn that during a

decrease in demand the reduction of production and the dismissal of workmen would not bring any significant results and, therefore, the adoption of automation induces the establishment to maintain a constant level of production and employment in spite of the fluctuations of the market.

Secondly, the adoption of automation is a long-term process which requires varied technical and economic research and computations, designing of new equipment, changes in the technology, the organization of the firm, and the design of the products, and occasionally building operations, etc. Once the introduction of automation had begun it must be brought to completion lest the great portion of the funds expended be irrevocably lost. Accordingly, the planned adoption of automation once begun will be continued even during the "temporary" difficulties in the market, which fact will in its turn help to overcome these difficulties.

Without doubt each of the above arguments possesses a grain of reason. However, it is easily proved that the "stabilizing effect" which automation exercises on certain sectors of capitalistic economy does not increase the over-all stability of the economic system but to the contrary, significantly increases its instability by aggravating the conflict between the organization of production at the individual industries and the anarchy of production on the scale of the entire society.

A continuous production rhythm must be maintained in automated production which can be adapted to the fluctuations of the market only with extreme difficulty. In this respect the automatic factory "loses flexibility" regardless of the fact whether in the future the automatic machines will be sufficiently flexible to permit a rapid rearrangement for executing a different production program. Therefore, neither argument on the "stabilizing effect" of automation eliminates the problem of its negative results under capitalism. The first argument shows that automation only creates new conditions which under capitalism increase the danger of overproduction. The same is true with respect to the second argument; the necessity of completing the program of automation once it is begun, in spite of the fluctuations of the business conditions, aggravates the trend toward the appearance of excessive industrial capacities.

Certain reformist authors assert that automation ensures the highest living standard for the population in general and, therefore, it is no longer necessary for "society to be based on the poverty of the many for the wealth of the few." Today, in the opinion of these authors "the privileged few are forced by the dynamism of production to develop the purchasing power of the people so that the production system may continue to function."

It is true that automation creates the technical conditions for an unprecedented increase in the living standard of humanity. However, by this very fact, automation aggravates extremely all of the problems and paradoxes of capitalism and the very existence of capitalism is becoming more and more an anachronism. It is true that automation does not only permit but even needs a sharp increase in the living standard of millions of people. Otherwise "the production system cannot continue to function" and overproduction and an economic crisis will inevitably occur on an

immense scale. However, precisely such a rise in the standard of life of humanity is beyond the powers of capitalism and it is precisely because of this that automation does not merely increase the danger of overproduction but also emphasizes the inevitability of the death of capitalism and the establishment of the socialistic society.

The bourgeois economists assert almost unanimously that automation will result in a general increase in workers' wages and thereby will ensure the high purchasing capacity of the population. These apologists of the capitalistic method of production state with an amazing earnestness that even now the wages of workmen who have been transferred to the automated sectors, have increased. It is true that under the economic conditions which prevailed in the principal capitalistic countries until the first half of 1957, some unions succeeded (but not always, by far) in increasing the wage level of the workers of automated sectors. Let us, however, permit the bourgeois science itself tell of the size of this increase.

The West German sociologist Pollock discussed this question in some detail. Here is his conclusion: "The statement that new jobs (i.e. the jobs connected with automatic equipment. Ya. A.) brought about an increase in the income of those who work at these jobs is extremely debatable. In the few investigations that have been conducted until the present time no increase in income has ever been mentioned. In an analysis made by the US Department of Labor it is noted that hourly wages for work at automated sectors of the production line were established at 5-15% higher than the wages of unskilled workers on the assembly line, upon taking into account the differences in working conditions and a greater responsibility."

Let us disregard the fact that the investigations of individual instances of automation published from time to time by the US Department of Labor are distinguished by a deliberate selection of "facts" which prove the "cooperation between labor and capital." However, even under these conditions the investigation states that the wages at the automated sectors of work are "5-15% higher than the hourly wages of unskilled workers." This means that this insignificant raise is effective only for the few lucky ones who obtained employment at the automated factories. However, for the majority of the workers who had worked on this sector prior to automation even such a miserly raise in wages is out of the question. At best they can find work according to their qualifications and their wages will not be cut. At worst, the dismissed workers find low-paying jobs not in their profession[6] /See Note/ or simply become unemployed.

(/Note/[6] In this respect the headline in the British newspaper Birmingham Post of 22 March 1956 is quite characteristic. It reads: "There are More Rubbish Collectors in Birmingham. The Result of the Dismissal of Workers at the Automobile Plants.")

The fact that the wages of workers at the automated sectors are not always higher than their wages at the same sectors prior to automation is evident, for example, from the experience of workers at the Ford plants which was referred to by the representatives of the Automotive Workers

Union in April 1958 at the Conference on Automation organized by the American labor union association AFL-CIO. The investigation of the Automotive Workers Union disclosed that at the automated pressworking plant in Cleveland the mean hourly wage of industrial workers was approximately 11 cents lower than in the old, nonautomated plant in Dearborn. The Union succeeded in raising the wages at the automated plant to the previous level only after prolonged negotiations and a threat of a strike.

Incidentally, the same bourgeois economics which predicts a general rise in wages ensuring the necessary purchasing capacity for the population when the problem of the market is mentioned, speaks quite differently on the subject of the workers' demand for higher wages.

Let us again give as evidence the words of the much quoted Eintsig whose book expresses the point of view of capitalistic industrialists in the classically pure form. Eintsig states repeatedly that the future increase in workers' wages will be one of the causes which will not let automation lead to difficulties in marketing and an overproduction crisis. But this assertion does not prevent him from blaming the British working class and British labor unions in other sections of the book for the alleged fact that their demands for wage increases are the principal deterrent to the adoption of automation in Britain and even the "principal potential cause of the depression."

When Eintsig speaks of wages and not of the market problem, he decisively refutes the conclusion that automation must bring increased wages to the worker. Here are some of his arguments: (1) Automation is introduced by the industrialists and not by the workers. Therefore, there is no reason why the working class should demand certain advantages for itself in connection with automation. (2) A raise in wages would lead to inflation. (3) An increase in wages at the plants which have adopted automation would mean a harmful difference in the wage level between automated and nonautomated plants and industries. (4) An increase in wages would retard the introduction of automation because the industrialists would not have sufficient funds for investments, etc.

The essence of the problem of course does not lie in the reasoning of the bourgeois economists. At every given stage the actual change in wages as well as the change in prices of all other commodities at the capitalistic market is established by the relationship between supply and demand. By adopting automation capital affects both sides simultaneously: at the newly built plants and in the new branches of industry automation relatively decreases the demand for labor, whereas at the working plants and in the "old" branches of industry it increases the absolute supply of labor force. When the wages are decreased the economic advantage of adoption of automation increases for the industrialist and this increases the rates of introduction of automatic equipment. This directly results in the dismissal of workers which fact in its turn increases the supply of labor force permitting the capitalists to break the resistance of the workers once again and to lower the wages.

The bourgeois science of economics has still another argument against the assertion that the introduction of automation aggravates

drastically the problem of the market. The essence of this argument can be reduced to the following: automation sharply decreases production costs and this results in an appreciable decrease in retail prices which fact in its turn increases the demand for goods, and consequently, expands the market.

It is true that automation in some instances reduces production costs by as much as one half. However, until the present time in the capitalistic countries there was not a single instance of a decrease in prices as the result of automation. Quite to the contrary, the price level is rising. The changes in prices on the market do not reflect the changes of production costs. The relatively high level of business conditions which existed prior to the first half of 1957 in the principal capitalist countries permitted the firms which had lowered their production costs through automation, to sell their goods at the original or even higher prices and thereby increase their profits. /See Note 7/ Even the 1957-1958 recession in the United States did not bring about a decrease in prices; to the contrary, during the recession the prices continued to rise. /See Note 8/

(/Note 7/ Eintsig of course obligingly offers reasons why everything should be just like it is. High profits, he writes, are necessary, so that "the risks taken by the industrialist and investor would be eased, encouraged and rewarded;" high dividends for the stockholders are inevitable because "after all it is their money that paid for the new equipment;" a lowering of prices would bring about unemployment and a depression and, to the contrary, a constant increase in prices is a sure guarantee against any depression and unemployment. Peculiar logic, isn't it? However, Eintsig does not stop here. He considers that an increase in prices is a good argument against an increase in wages: "...when prices tend to rise the economic arguments for higher wages resulting from apprehension that the purchasing capacity of the consumer will be inadequate, are obviously invalid." Eintsig probably thinks that his readers are entirely devoid of common sense.)

(/Note 8/ In the US the retail and wholesale prices in the third quarter of 1958 were respectively 0.8% and 2.3% higher than in the third quarter of 1957.)

One of the causes of this phenomenon, in addition to the increasing inflation, is the significant increase in the influence of monopolies and the growth of the share of prices set by monopolies in the American economy. Automation is being adopted at the most rapid rate precisely in the most monopolized branches of the American industry.

It is quite possible, however, that in the future with the further progress of automation there will be a decrease in prices in the branches of industry which are less intensively controled by monopolies. Companies which had adopted automation could, in the event of great difficulties in marketing, use their technical superiority in order to win the market and oust their competitors by a drastic decrease in prices. The consequent bankruptcy of the companies which lagged in the development of automation would signify on the one hand, an increase in unemployment and,

therefore, a further deepening of the depression, and on the other, a rapid increase in the concentration and centralization of capital, a strengthening of the power of the largest monopolies.

An acceleration in the monopolization of capitalist production as the result of automation occurs, of course, not only in time of a depression. The rate in the development of monopolies is only increased by a depression. Transition to automation appreciably increases the monopolistic tendencies in each phase of the cycle. We must dwell on this question a little longer because the literature of the bourgeois economics has created here an exceptionally great confusion and attempts to conceal in every possible way the real tendencies connected with the development of automation.

Certain bourgeois economists, referring to the increasing feasibility of using automation even in small-lot production and to the fact that the prices of automatic equipment are often no higher and sometimes even lower than the prices of "ordinary" equipment, assert that automation ostensibly improves the ability for competition of small and medium-sized companies making it possible for them to march in step with the larger firms in respect to the technical development. Others, to the contrary, claim that automated production inevitably loses flexibility and that the large firms which had introduced automation will not be capable of adapting themselves in time to the variations in the market and the requirements of the consumers. They also refer to the fact that automation of a medium-sized plant with an uncomplicated single-type production is more easily achieved than automation of a large plant with a large assortment of products or a plant producing very complicated equipment. Therefore, in their opinion the smaller firms will increase their ability to compete, as the result of automation. There is still another group of economists which sees the salvation for small and medium firms in the trend toward decentralization of plants and a decrease in their size which is observed during the latter years in some branches of industry in capitalist countries.

It is correct that the growing tendency toward an increase in the flexibility of automatic equipment in certain instances permits even today and in the future will permit more frequently the use of automation in small-lot production. It is also beyond any doubt that the prices of certain types of automatic equipment are such that small and medium firms can well afford them.

However, the largest monopolies lead in the adoption of automation in all capitalist countries without exception. The initial introduction of automation, as well as any first steps of new technology require the work of a great number of engineers and technicians of various branches of technology and a great outlay of funds for the research work, the reorganization of the establishment, redesigning of the product, construction of prototypes, etc. As a rule only the largest firms are capable of these undertakings. Thereto we must add that inasmuch as the solution in principle of the "flexibility problem" is still in the intial stage automation in most instances is used today only in mass production. Thus the large monopolies increase their lead in the race with the smaller competitors.

The extent of this lead will increase rapidly in the future also. Automation is introduced more rapidly than it is necessary to replace worn equipment with new, thereby speeding up the rates of obsolescence of the machines. Hence the firm which wishes to keep pace with the technical progress cannot fall back on depreciation deductions only when it modernizes its equipment; even when the price of automatic equipment is no higher than the price of the working "ordinary" equipment, it must expend additional capital. This additional capital is not identical with the capital which is necessary for production on an expanded scale. It covers only the losses incurred through premature replacement of the existing, incompletely depreciated equipment. Large monopolies which receive maximum profits, possess immense reserves, and have close relations with banks, can invest the additional funds required with incomparably greater ease.

We must also note that even the definitive solution of the "problem of flexibility" will bring no advantages to the small and medium manufacturers: on the one hand, the feasibility of automation of piece production does not change the technical and economic advantages of mass production, and on the other hand, automation of piece and small-lot production is not necessarily identical to the automation of small establishments but pertains primarily to the large plants with piece production on a large scale.

The same can be said of the trend toward the decrease in the size of the establishments. When this argument is used, reference is usually made to the development of the electronics industry in the USA where in 1957 there were approximately 4,000 firms only 2.8% of which had more than 500 workers and 82% had less than 50 workers. This great dispersal occurred owing to a number of temporary causes. At the time of a relatively good business conditions the industrial giants were not prepared to change their profitable production programs and permitted the small firms to take the risk of technical and commercial experiments in the new and untried field. Moreover, the newly born branch of industry permits the creation of many new small establishments whose existence is based on the possession of several patents. Lastly, the rapid growth of the demand for instruments and other means of automation attracted various small and medium profiteers into the new branch of industry.

However, even today in this new branch of industry which is pictured by many as heaven for small industrialists, in spite of an apparent dispersion, a high concentration and centralization exists: of the 1,000 firms manufacturing finished apparatus, 50 largest ones (i.e. 5%) account for more than 80% of the entire volume of production. Approximately 80% of the production of parts is concentrated in the hands of 10% of the largest firms.

The assertion that full automation is technically more feasible in medium, narrowly specialized plants than in large plants with a wide variety of products, is entirely correct. A medium size plant producing only spark plugs or engine pistons is easier to automate than a large plant producing entire automobiles. The principal factors consist firstly

in the complicated character of the technological cycle, secondly in the mass nature of production. The mass nature of production is not determined by the size of the plant (i.e. by the number of workers or the total production volume) but by the scale of the single-item production. Therefore a medium-size, narrowly specialized plant producing a single type of article from the point of view of mass production and of the complexity of the technology manifests much more favorable conditions for adoption of automation than a large plant of the same branch of industry with a universal equipment and a large assortment of items produced. However, this pertains only to the problem of the specialization of the plant and the mass nature of production and the question as to whether this plant belongs to a large or a medium firm, i.e., the problem of centralization and concentration of capital, is not pertinent.

Owing to many causes which cannot be examined within the bounds of this book, large American monopolies (Ford, General Motors, General Electric, Dupont, Alcoa, and others) during the recent years have preferred in certain instances to build several smaller plants specialized in making individual products or in performing individual phases of the technological cycle instead of a large plant with a complex production cycle. That which was a shop or a department of a large plant is now a technically independent plant. Thereby the average size of the plants is decreased. For example, one of the old General Electric plants has approximately 20,000 workers whereas the new plants of the same firm employ 50 to 1,500 workers.

This is related to a certain extent to the territorial decentralization. Automation significantly increases this trend. Decentralization of industry under modern conditions becomes one of the means of centralization and concentration of capital. It permits the larger firms to appropriate certain advantages which until the present time had helped small and medium firms in their struggle against larger competitors, namely: closer proximity to the consumers, more effective management, greater ability to respond to the individual requirements of the customers, and, primarily, the feasibility of building a new plant in remote, poorly developed regions with a low wage level and weak organization of the workers.

The development of capitalistic industry leads to monopoly. This objective tendency of capitalism is not removed by automation but to the contrary, appreciably intensified by it.

Until 1957, automation was adopted in capitalist countries under especially favorable conditions. Good business conditions in the principal capitalistic countries resulted in a relative reduction in unemployment. This fact, together with the growing influence and organization of labor unions resulted in a certain rise in the nominal wages. Under these conditions capital outlay for equipment which replaces the workers proved to be exceptionally advantageous for the industrialists. At the same time the relatively rapid rates in the development of production permitted the adoption of automation mostly at the expense of expanding production or constructing new plants, which fact again increased its economic effectiveness.

Today these favorable conditions are rapidly disappearing. The

1957-1958 recession in the USA resulted in a serious fall in production. And although during the first half of 1959 the American industry surpassed its former 1956 level, nevertheless the serious recession phenomena, primarily the high unemployment and large unused industrial capacities still persist and are manifest even in certain other capitalist countries.

What was the effect of the recession on the rates and scales of the further adoption of automation in capitalistic countries? The following general picture can be formed from the data available.

The total volume of investments in 1958 in the USA was 17% below the 1957 level but still somewhat higher than the 1953-1955 level.

Table 11

Capital Investments in the US (in million $)

1953	1954	1955	1956	1957	1958
28,322	26,827	28,701	35,081	36,962	30,526

In the principal branches of national economy, however, the decrease in the volume of investments was significantly greater. In 1958, for example, investments in the manufacturing industry decreased 28%, in mining 24%, and in railroads 46%. In the general decrease in the volume of investments the outlay for industrial construction was reduced most of all. In spite of this the demand for automation equipment retained its high level and even increased to a certain extent.

In the USA the volume of the capital outlay in 1959 is expected to exceed the 1958 outlay by 4%. Meanwhile, approximately 66% of all investments is earmarked for the modernization of the existing plants and only one third for the increase of the industrial capacities. This signifies that a violent struggle for sales is in the making. The monopolies are in a hurry. They are selecting the most rapid way of introducing automation, namely, the modernization of the existing plants in order to outstrip their competitors.

The firms which lagged in their technical development and which could nevertheless stay in business owing to the prevailing conditions are now given a deadline for adopting automation. "The economics of automation is unpleasant but simple; it is -- automate or die", remarked one of the heads of the American automobile firm Chrysler Corporation. This pertains not only to the position of individual firms in the internal markets of the capitalist countries but also to the position of individual capitalistic countries in the world market.

The adoption of automation is significantly accelerated in the principal capitalist countries. However, the general economic conditions at the present time have deteriorated in comparison with the 1955-1956 period; unemployment and unused productive capacities have increased, the growth of production has slowed down.

The development of automation which was the main cause of the new increase in capital outlay and, therefore, was one of the factors responsible for overcoming the 1957-1958 recession, simultaneously acts in the direction of further deterioration of the general economic conditions and the onset of a new depression.

3. Automation and Working Conditions

Combining separate machines into automatic production lines and machine systems eliminates the exhausting and frequently dangerous manual labor especially in charging the machines and in transportation between operations. The movement of materials and their manufacturing is performed automatically without direct participation by man. Therefore, the worker is not exposed to the action of caustic, corrosive, boiling, irritating, and other substances hazardous to health. At automated sectors the worker practically never touches the moving parts of the machine. This eliminates or at least significantly reduces the danger of crippling accidents on the job. Automatic control and regulation increase industrial safety and appreciably decrease the number of accidents and injuries which frequently lead to physical disabilities and may even be dangerous to life. The control and regulation of automatic machines is performed from a central control room which in the event of necessity can be located in a detached building and be completely isolated from the industrial equipment. The operator works in entirely safe surroundings and is not exposed to noise, humidity, odors, dust, drafts, heat, changes in temperature, etc., which are unpleasant and frequently hazardous to the health.

In this manner automation increases the technical prerequisites for a material improvement in working conditions, eliminates fatiguing strain, increases work safety, reduces the number of professional disabilities and sicknesses.

However, this condition is entirely immaterial for the capitalist industrialist, since this is not an item in the calculation. Walter Reuther, the President of the American Automotive Workers Union made the following remark on the subject: "You can say many things about General Motors except that it is a philanthropic organization. In any event it is not introducing automation in order to ease the labor of the workers on the production line." It is well known that Reuther is closely connected with the industrialists, but we can, without doubt, believe his opinion on their philanthropic inclinations.

The merciless pursuit of profit leads to the fact that automation which in itself is a powerful tool for the all-round alleviation of labor, under capitalism frequently results in exactly the opposite consequences.

The bourgeois economists are trying in every way to prove that automation in capitalistic plants improve working conditions, and give examples which show that upon the adoption of automatic equipment in certain plants the number of crippling accidents decreased. However, the discussions of the bourgeois economists are not convincing.

Firstly, all the examples given by them pertain only to industrial workers. The working conditions for maintenance workers whose proportional number in the total number of permanent workers has greatly increased with the introduction of automation, have gravely deteriorated at the capitalistic plants. The General Director of the International Labor Bureau, D. A. Morse called the public's attention to the fact that the danger of accidents incurred during repairs of automatic equipment increases owing to the great complexity and the large size of the equipment, mainly in the instances when the repairs are performed while the machine is in operation.

Automation as such is not responsible for this. Accidents could be easily avoided if the automatic production lines and machine assemblies would be equipped with appropriate protective devices. It is necessary to stop the machine during the complex repair operations when the worker has to handle the moving parts of the mechanism or is exposed to other dangers. The stoppage of the machine and disturbance of the rhythm of the automatic production will naturally result in certain losses. However, no capitalist will voluntarily consent to spend his funds for these purposes.

Secondly, the desire to reduce costs regardless of consequences results in a negligent attitude of the industrialists toward safety measures in adoption of automatic equipment. This increases the accident hazard even for industrial workers who attend the automatic machines. D. A. Morse, for example, says: "Certain firms which are turning to automation have established that the number of accidents increased during the period of installation and adjustment of the automatic equipment." In the book of the British progressive worker, Lilli, Automation and Social Progress gives an especially illustrative example of a fatal accident resulting from the absence of the most elementary safety measures at one of the large British automobile plants.

Deterioration of working conditions is brought about by the adoption of automation under capitalism because of yet another reason. Automation which by itself creates the technical conditions for a substantial shortening of working time under capitalism frequently results in longer working hours. In striving to cover the expenses incurred in the introduction of automatic equipment, the industrialists try to utilize it as much as possible This results in an increase in overtime. This is verified by the experience of the sectors of the American industry in which automation was adopted.

Lastly, during the recent years in most of the industrial capitalist countries the type of industrial disabilities and illnesses is greatly modified owing to the rapid increase in the number and proportion of cases of illnesses and disturbances of a nervous nature. For example, a medical investigation on the changes in the state of health of workers in the Federated German Republic arrives at the following conclusions:

1. The number of cases of afflictions characterized by disturbances of the nervous system is constantly increasing.
2. The share of deaths and disabilities caused by these afflictions is increasing.
3. The diseases of the nervous system result in irreparable harm to health.

4. Physicians are unanimous in stating that the cause of the increasing number of cases of disturbances in the nervous system is the increased nervous fatigue.

The rapid increase in the numbers of various nervous diseases and disturbances is not, of course, due to automation alone but represents the consequences of the entire complex of the working and living conditions of the workers under modern capitalism. However, automation, or more correctly, its capitalistic application which has no regard for the health of the worker and is connected with an increase in the intensiveness of labor aggravates the old causes of nervous exhaustion and psychic illnesses and creates new causes therefor. D. A. Morse whom we have already quoted makes the following statement on the subject: "...nervous strain may appear as the result of the demands put upon the operator by the control of complex equipment and continuous processes; physical exhaustion may be replaced with psychic exhaustion; a change in surroundings and a greater responsibility can affect psychological health... Several investigations performed in America and Europe show that there is a greater number of nervous workers at automated plants than at nonautomated plants." In the report prepared by the International Labor Bureau for the Sixth Session of the Machine Building Commission of the International Labor Organization it is similarly stated that"...although the recent experience shows that the new positions by the automatic equipment are safer and that in the new plants the surroundings are more pleasant, the physical safety and health of the individual worker may be jeopardized as the result of an increased psychological strain..."

The increasing nervous exhaustion is generally caused by two principal causes. The first indirect cause is the fact that automation under capitalism aggravates the danger of unemployment and thereby increases the over-all insecurity in the living conditions of the worker. The second direct cause is determined by the fact that even with automation the industrialists still strive to wring maximum production from the workmen and thus decrease the wage costs. Whereas formerly these efforts of the industrialists resulted in physical exhaustion of the workman and accidents caused by handling of the material or the moving parts of the mechanism, today under the conditions of automation they result in nervous strain and the emergence of new professional diseases. Automation creates new conditions under which the old cause produces somewhat different consequences.

We may remark that this cause has found a distorted expression even in the bourgeois literature in terms of a theory according to which the cause of the industrial traumatism is the poor ability of certain workers for adapting themselves to the new working conditions. The French physician V. Lafitte agrily criticizes this theory and tells of the "indignation-provoking concept according to which the worker must adapt himself to the machine instead of adapting the working conditions to the physiological capabilities of man. This is a cruel admission of the fact that in our society the machine created by man enslaves the worker." This physician gives an accurate characteristic of the capitalistic usage of the machines.

Automation which in itself is a major victory of man over the forces of nature and which should free the workman from the cruel subjection to the rhythm of the machine, under capitalistic conditions brings about the opposite results. Richard, the representative of the French labor union organization "Force Ouvrier" stated at a session of the Economic Council of the Republic in the course of debates on the subject of economic and social consequences of automation: "...the highly automated factories enforce upon the worker who has escaped dismissal an enslavement worse than that to which he was subjected prior to the introduction of automation."

The American labor union officials in demonstrating the effect of automation on the working conditions often tell the following story: "Some workmen are unable to keep pace with automation. This happened for example, with Stanley Tylak. After his 61st birthday and after he had worked for 27 years as a fitter at Ford plants, he was transferred from the mechanical shop of the foundry at River Rouge to a new automatic plant manufacturing engines. He was given the job of operating a new large automatic machine."

In plain words Tylak frankly tells his story: "The machine has approximately 80 drills, and machines 22 blocks simultaneously. You must watch it all the time. Every minute you must check everything to be sure that all is in working order. And these machines have so many lights and switches! There are about 90 lights only! Of course, it makes your head spin.

When the machine breaks down the whole line stops. But sometimes you make a small mistake, and this is bad for you, for the foreman, for the company, and for the union."

Thus Tylak was destroyed by the machine with the rate of which he could not cope. Now he has to work at a lower paying job.

Tylak had to leave. Others, younger than he, remain -- until such time when the high nervous tension brought on by the pressure of controlling complex equipment working at an extremely rapid rate will put them out of commission. However, the problem of nervous tension could have been solved in this and in other similar instances by one of the relatively simple methods: the rate of the machine could have been adapted to the capabilities of the average workman, or with the same rhythm retained the workman could have been given an assistant, or, finally, the automatic production line could be equipped with an automatic control and regulation system. However, all this required additional expenses, and from the point of view of the capitalist industrialist these expenses are superfluous and are equivalent to throwing their money away.

Automation is still in the initial stage of its development, therefore the practical experience of its adoption is extremely limited. The statistics on industrial accidents and occupational diseases is not sufficiently detailed to afford the separation of the effect of automation from other causes. The general data point only to the fact that nervous breakdowns in many industrial capitalistic countries are on the increase. Unfortunately the total data give no indications of the effect of automation on this increase. However, although it is now as yet impossible to

express in figures the effect of automation on industrial accidents and occupational diseases, the principal trends are sufficiently apparent. In the capitalist countries upon the adoption of automation the number of physical disabilities and diseases was reduced but the number of disturbances and diseases caused by nervous tension is on the increase. Whereas formerly it was the hands of the workman that were primarily endangered, today under the conditions of automation it is his nervous system that is exposed to danger.

The same pertains to the working conditions in general. Under capitalism automation replaces one type of fatigue with another, physical exhaustion is replaced with nervous tension. Investigations performed several years ago by an American university resulted in the following conclusions: "the main complaint of the workers in the new automated factories is that muscular fatigue is replaced with psychological strain... The new machines eliminated the fatiguing work but strain resulting from watching their work and controlling their activity makes the workers nervous...The work is easier physically, but when the workers go home their heads ache instead of their backs."

At the conference on automation organized by the American trade union association AFL-CIO in 1958, the representatives of the Rubber and Plastics Workers Union Joseph Childs and Ralph Bergman said: "Technical advances and automatic machines caused the workman to become even more subjugated by the rhythm of the machine" and that as the result of automation the tempo of the machines increased 50%. This is the direct cause of the nervous exhaustion of workers. Actually the problem discussed here is the same as in Stanley Tylak's story and in the speech of Richard, the representative of the French labor union organization Force Ouvrier.

From the technical point of view this problem consists of the following. In first stages of its development automation does not yet eliminate entirely the necessity for constant participation of the worker in the course of the technological process. For example, the workman must still supply the material to the machine, or clamp the billets at the initial working position of the automatic production line, or transfer the semi-product from one line to the other, or adjust the course of the process according to the data of the controlling devices, etc. In this manner the rate of his work is directly subordinate to the tempo of the machine and to a much greater extent than in the operation of nonautomated equipment. This is undoubtedly an unfavorable moment in the development of automation, which, however, can at least be restricted to a certain extent by adjusting the operating speed of the automatic production line or installation to the physiological capabilities of the average worker or by the adaptation of the workers on the individual sectors to the operating rate of the automatic equipment.

Under the conditions of the capitalist pursuit of profit this aspect is the technical basis for increasing the intensity of work. However, the very development of automation eliminates it. Instead of the worker the automatic regulator adjusts the course of the process according to the data of the apparatus. The automatic devices perform

the most complicated operations with the raw material and half finished products. Automation in its highest forms, as it had been mentioned earlier, liberates man entirely from direct participation in the industrial process and thus liberates him from subjugation to the rhythm of the machine. Man's duty in the fully automated plant no longer consists of continuous operation of the machines and a continuous participation in the course of the industrial process. His new functions are the development of the program of the work of automatic machines, their adjustment and repairs.

However, the technical possibility is not yet an actual reality. The work of the man transferring the semiproduct from one automatic line to the other is unskilled and therefore poorly paid. Therefore, the industrialists frequently prefer to use the lower forms of automation declining to make use of the possibilities offered by the technological development. For example, John Diebold, the well known American theoretician of automation writes: "Rather than automate the entire process the best solution appears to be, -- and actually it occurs quite often, -- somewhere between the existing level and full automation." He is also the author of the following statement: "An 80 or 90% automation of the process can result in a great economy. The attempt to automate the remaining ten or twenty percent might make the entire operation uneconomical." This discourse is caused by the need for a "scientific" justification of the capitalists who from purely mercenary motives, in order to obtain the greatest profits, strive to retain the lower forms of automation along with the subjugation of the worker to the rhythm of the machine.

Thus, automation in the hands of the capitalistic industrialists serves as a new implement for increasing the intensity of labor and lengthening the working day, a new weapon for wringing out the sweat, which accelerates the premature exhaustion of the vital forces of the working man.

According to the communication in the New York Times, the assistant dean of the Social Security School in New York, Dr. Nathan Cohen "warned that the technical development aggravates the problem of psychological health in America...Man is capable of producing an ever increasing amount of products during a shorter period of time but he still has no guarantee that he will participate in utilizing the results of the increased productivity. In any event the expanding productivity without a regular increase in consumption results in the fact that the economic conditions of the worker are becoming ever more dangerous, his lack of confidence in the future is increasing and the increasing leisure time is more of a threat than a blessing." Hardly anything can be added to this characteristic of the consequences of automation for the status of the workers in the capitalistic countries. The words of Lenin sound as if they have been uttered today: "Wherever you go you encounter at every step the problems which humanity is capable of solving immediately. Capitalism stands in the way. It has accumulated mounds of riches and made the people slaves of these riches. It solved the most complicated problems of technology and halted the realization of the technological improvement because of the poverty and ignorance of millions of population, because of stupid stinginess of a handful of millionaires." (See V. I. Lenin, Sochineniya /Works/, volume 19, page 349.)

Chapter III

AUTOMATION UNDER SOCIALISM

(Past Achievements and Future Prospects)

1. Socialist Industrial Relations are the Foundation of the Fullest and Quickest Development of Automation

Automation offers mankind colossal and hitherto unseen possibilities. It elevates to a new and qualitatively higher level the productive powers of society and creates the material and technological conditions for abundance. However, the complete utilization of these opportunities depends upon the social structure of the society and upon the type of production relations.

As it has been pointed out in the foregoing chapter, automation under the conditions of capitalism leads the exacerbation of contradictions inherent in this social structure, instead of plenty it leads towards poverty. For modern capitalism the harsh words of Marx have not lost their significance: "...a machine as such cuts down the working time whereas its capitalist utilization actually lengthens a labor day...in itself it relieves the work, but its use by capitalism increases its intensity...as such it is a token of man's victory over the forces of nature, but its actual use makes a man a slave of these forces...in its essence it tends to increase the wealth of the producer, but in its capitalist application it reduces him to the state of a pauper, etc. /See K. Marx, Kapital, Vol I, pages 446-447/.

Automation affirms so convincingly the bankruptcy of the capitalist system of production that even numerous bourgeois authors are not in a position to deny this fact. It is true they make every effort to create an impression that planning and public control over production could be made effective under capitalism, but this is, as jurists put it, "an attempt to commit an act the commission of which in the manner proposed is impossible."

In the foregoing chapter we have quoted some statements by bourgeois authors. Here we shall only quote a West Germany sociologist, Friederich Pollock: "Automation may lead to the welfare of mankind only when a society-wide determination arise to utilize the new production forces directly and systematically for the benefit of mankind, which condition at present many people expect too optimistically to result from its uncontrolled development. Only under these conditions, "adds Pollock, "the words of another West Germany author (K. K. Doberer -- Ya. A) make sense, that the object of automation is not to create the surplus of labor, thereby saving on wages and cutting production costs, but to release the labor force for the purpose of finding solutions for problems which do not serve to satisfy our immediate needs and for which we still do not have spare manpower."

There is no question that Pollock was completely right, but his words lead to the inevitable conclusion which, of course, he was incapable of formulating: Only under socialism "it is possible to utilize automation directly and systematically towards the welfare of mankind." Society can acquire control over productive forces and use them methodically for the good of humanity only when the means of production are not held by a small group of exploiters but belong to the entire society, and when productive forces are no longer considered as capital but, in the words of Engels, they are recognized actually and fully as the productive forces of society.

The principal determining features of the socialist system are the transfer of political power to the working class and the transfer of the means of production from private to public ownership. Without this condition there is no socialism. Various defenders of the capitalist system may contrive all they like in their "theoretical" exercises but they will never refute this proposition.

New relations between men grow and develop upon the basis of socialist public property. The exploitation of one man by another is abolished and capitalist competition disappears. Relations between free and equal workers in the socialist society are established and become relations of cooperation and mutual help. This fundamental change of relations in the sphere of processes of production calls to life new forms and new possibilities in the development of social economy. Among them an important place belongs to the socialist utilization of automation.

Under socialism automation does not lead to unemployment and crises of overproduction because these phenomena are not the results of automation as such but of its capitalist application.[1] /See Note/ Socialist ownership of the means of production permits systematic and expedient utilization of all manpower and material sources for the maximum increase of social production.

/Note [1] An interesting point of view with which we fully concur is expressed by an editor of several American magazines devoted to the subject of automation, Milton G. Aronson: "Automation does not have any direct economic consequences. It cannot make a sick country healthy or a healthy country sick. It can make a healthy economy healthier and it can, of course, make a sickly economy still sicker. However, it cannot be a fundamental cause of economic stability or instability"/.

An uninterrupted growth of the number of workers and employees with a concurrent rise of productivity is an objective and typical process in all socialist nations. Thus, in the USSR, total industrial production increased in 1958 as compared to 1928 more than 27 times and the productivity of labor in industry (both state and cooperative) increased by 721%. The average annual employment figure of industrial workers and employees in 1932 showed 8,000,000 but in 1958 it increased to 19,600,000, i.e., 245.5%.

Under capitalism economic development proceeds with interruptions, spasmodically, from upsurge to crisis and from crisis to upsurge again. Socialist society has an opportunity for uninterrupted production growth. Automation under socialism does not lead to crises of overproduction, but

on the contrary, allows one to satisfy rapidly and fully the growing needs of the whole society and of its every member, and to raise the living standard of the population at a much more rapid pace than it was possible until now.

Socialist application of automation is one of the ways of creating the necessary material and technical conditions for a steep rise in the productivity of social labor, for the achievement of abundance of commodities and for the fulfillment of the historical goal of socialism, that is the construction of a communist society.

The complete and thorough automation of all branches of national economy and using computers to control the optimum rate of production process are the characteristic features of the material and technical basis for communism. Such a complete, all-embracing system of automation covering the entire sphere of production presents one of the qualitative differences between the material-technical base of communism and the material-technical base of capitalism.

Socialist production relations open up wide fields for the development of automation. The rapid pace of uninterrupted growth in production and the constantly growing level of wages created the most favorable conditions for the introduction of automation into all branches of the national economy. The growing needs on the part of the people for various commodities require an accelerated pace for the introduction of automation, whereas the steadily increasing purchasing power of the population makes it possible and necessary.

The scope of automation, as well as the scope for using machinery in general, is much broader under socialism than under capitalism. A capitalist enterpriser does not pay for the labor of his worker, he pays only the price of such labor. Therefore, as far as he is concerned the problem of how far to go with automation is determined merely upon the difference between the price of automatic equipment and savings on wages. Under socialism these limits are determined by the consideration that labor expended for building automated equipment must be less than the total labor saved as a result of the use of such equipment. Hence the break-even point is reached sooner under the socialist system as compared to the capitalist system, much as the value of daily work exceeds the value of its small portion corresponding to the worker's wage. It must further be taken into consideration that under socialism the introduction of automation is fully justified in those instances when its result is not just a material return but also the improvement of working conditions, increased safety, avoidance of retaining personnel in areas harmful to health, etc.

Public ownership of the means of production and socialist planning of the national economy offer an opportunity to plan the distribution of manpower and equipment for the purpose of working out the basic and decisive problems of technical development, making these results widely available and utilizing them in all branches of the national economy to maximum advantage. Under capitalism, however, the competitive struggle of monopolist groups inevitably leads to an ever greater dispersal of effort

and equipment. Likewise, parallel activities are carried out in a number of places without necessary coordination and without exchange of experiences and, naturally, without using such achieved results for general progress. Under socialism, for example, there are no such hindrances in the way of technical progress as commercial secrets or patent limitations by means of which capitalist enterprisers deprive their competitors of the opportunities to use their discoveries and inventions thereby holding back the widespread introduction of technical innovations in the whole sphere of national economy.

The planned manner of introducing automation into the national economies of socialist countries makes it possible to keep it under the control of society. The impossibility of such control in an anarchistic and spontaneously developing economy of capitalist countries is one of the causes of social disasters confronting the workers in bourgeois states. Using this advantage of socialism over capitalism the 21st Congress of the Communist Party of the Soviet Union declared in their resolution: "In connection with the fact that steps toward mechanization and broader automation of production are not only important economically, but possess a great social significance, the Congress directs the Central Committee of the Party and local party agencies to carry out an unremitting control over implementation of all the necessary steps for complete mechanization and automation of industry." /See Materialy vneocherednogo XXI s"yezda KPSS /Records of the Extraordinary XXI Congress CPSU/, Gospolitizdat, 1959, page 148/.

To be able to carry out the conversion to complete automation within the shortest period of time and with utmost conservation of equipment and manpower, it is necessary to carry out a wide coordination of all the efforts for the development of automation in accordance with a single general plan for the entire country. An exceptionally important part is played by a scientific selection of the most important prototype production centers in various branches of industry, the concentration of the main forces of science and technology for the purpose of working out the problems of complete automation of these centers, coordination of the results, and a system for making all such information available in all similar or related types of production centers and factories.

Already in the Soviet Union steps in this direction are being taken on a large scale. For example, ever since 1956 pilot types of completely automated factories are being developed in the food industry. Thus the problem for all-round automation in raw sugar and sugar refining plants, four types of oil and fats industry, four types of bread baking factories, canneries, alcohol distilleries, breweries, etc. are being solved. Experience gained in the design construction and operation of these experimental completely automated plants will in the future be expanded to cover both the existing plants and those under construction. Likewise, in the chemical industry design work is being carried out towards the development of prototype complete automation of four nitrogen-fertilizer plants, a tire plant, in the contact method of producing sulfuric acid and in the production of weed-killers, benzidine, a double superphosphate, polyethylene, synthetic alcohol, etc.

Work in this direction is of exceptionally great significance because the correct selection of typical objectives and the concentration of main forces in the development of their complete automation will provide the solution of basic theoretical, technical and economic problems for the broad implementation of complete automation in the national economy within a relatively short period and with greater effect. The availability of practical examples of complete automation in the more important production spheres will be a dependable basis for further development of automation of the entire national economy on a high scientific and technical level.

Following the example of the Soviet Union, other countries of the socialist camp envisage in their national economic plans, the creation of model experimental completely automated departments, production units, and whole enterprises in the fundamental branches of industry.

Capitalist pursuit of profits consistently directs available manpower and materials toward the solution of only those problems which promise an immediate return. Socialist industrial relations produce a different result. For the purpose of creating a scientific project they will readily concentrate the best scientific and technical forces, and furnish them with the necessary material means for the solution of such problems. This may not bring about an immediate economic return but will help to carry out a revolutionary leap in the development of science and technology in the future. This is witnessed for example by the well-known achievements of Soviet science and technology in areas of peaceful application of atomic energy, launching of artificial earth satelites, cosmic rockets, etc.

The same statement holds true as far as the scientific development of the principles of automation is concerned. For example, one of the most important problems of automation is the development of the theory of non-linear systems of automatic controls. Inasmuch as this theory is still insufficiently developed, the results of research in this sphere are more of theoretical than practical value. For the future, however, this work is of exceptional importance. The solution of fundamental problems of the theory of non-linear systems will not only greatly expand the field of application for automatic controls, but will guarantee the creation of more dependable and economical systems than the currently existing linear systems of automatic controls. It is no accident that in the development of the theory of non-linear systems, Soviet science has substantially overtaken the science of capitalist countries. This fact is at present recognized even by bourgeois specialists on automation.

One of the most important prerequisites for rapid development in automation is the availability of highly qualified specialized personnel. This condition holds true for any form of technical development and even more so for automation which sets before science and technology unusually important and complex problems. Almost all the authors writing in capitalist countries about automation consider that from a technical viewpoint the greatest hindrance is a lack in sufficient numbers of engineers and technicians. Advantages of the socialist political structure, offering the wide masses free access to education, are clearly displayed by a comparison of the training pace of engineers in USSR and in capitalist countries.

Only where industrial relations of a socialist type prevail, with public owned industrial facilities, it is possible to fully utilize the immense advantages of the modern accounting technique for the development of the productive powers of a country. "In the very near future," write Academician A. Blagonravov and B. Semkov, "in Gosplan [State Planning Committee] USSR, in TsSU [Tsentral'noye Statisticheskoye Upravleniye -- Central Statistical Administration] USSR, in gosplans of individual republics, and in sovnarkhoz organizations [Councils of National Economy], computer centers must be established which will continuously receive coded information through communication channels for further processing. A machine takes care of all this very quickly and accurately. There will not only be a possibility to digest current information, but also to develop optimum variations in the plans for the national economy. Less complicated electronic computing machines will be needed in various enterprises for planning and accounting. As a result a whole network of computing centers and stations will be established all over the country and connected to a unified system."

A very important factor, which is entirely absent and impossible under conditions of capitalism, in the acceleration of development in automation in socialist countries is the creative initiative of the working masses. Development of automation in socialist countries became a vital concern of the workers, a veritable nation-wide movement. It is characteristic that the first automatic line in the USSR, which was put into operation in the Stalingrad Tractor Plant in 1939, was constructed under the guidance of a worker and inventor of the STZ [Stalingradskiy Traktornyy Zavod -- Stalingrad Tractor Plant] mechanic, I. P. Inochkin. There are a number of similar examples. Among them the Darnitsky bread factory, the first automatic baking plant in USSR, was built and assembled in accordance with the design of engineer Pevnev by a collective group of bakers of the city of Kiev. In the capital of the Ukraine there was not a single baking establishment which did not participate in the construction of this automatic bread factory. The first device in the world for automatically driving a tractor was created and tested in actual field conditions by tractor driver and inventor, I. G. Loginov. The collective body of the "Freser" factory in Moscow developed a long-term seven-year plan for all-round automation of production. By the end of 1958 the laborers in this plant set up for production eight automatic lines by means of modernizing the existing equipment.

A powerful new incentive to national creative initiative was given by a communication concerning the convocation of the June (1959) Plenary Meeting of TsK [Tsentral'nyy Komitet -- Central Committee] CPSU and their resolution. It is a characteristic feature of socialist competition, displayed in the course of carrying out the program set up by the plenary meeting, that various collective groups in the country accepted committments to speed up the introduction of complete mechanization and automation of production. Daily reports in the press testify to numerous cases showing an upsurge in the mass technical creative work of the workers in the USSR.

The number of trained specialists with college and high school level education in the national economy of USSR reached towards the end of 1958 about 7,500,000, i.e. 39 times as many as in 1913. In Soviet universities and colleges study approximately four times as many students as in England, France, West Germany, and Italy combined. The schools of higher learning in USSR graduate almost three times as many engineers as similar schools in the USA. According to an evaluation of a sub-committee of US Congress, the Soviet Union graduates every year from 30 to 40 times as many specialists with a high school level of technical education as the USA. During the period 1959-1965 the USSR will educate 1.9 times as many engineers for industry, construction, transportation and communication as in the previous seven years. The greatest rate of growth in training technical specialists is anticipated in chemical technology, automation, radio and electronics, and other branches of new technology.

In other countries of the socialist camp the rate of preparing specialists is also considerably higher than in capitalist countries. For example, in 1956 for every 10,000 residents of GDR there were 36.1 students in colleges and universities including 10.3 attending technical colleges. Corresponding numbers in West Germany are 26.6 and 5.6. There is no need to emphasize that superiority in the training of personnel helps solve problems in the development of automation in countries of the socialist camp very much faster than in capitalist countries.

A very important condition for substantially accelerating the development of automation as well as for finding greater opportunities for its utilization is the standardization of automatic equipment. The best designs and engineering solutions should be widely used and a universal and unified system of devices and equipment of automation constructed along the principle of building block machine tool components. This system is under active development in the Soviet Union. Initial steps were made in this direction in some other countries of the socialist camp. This will substantially help to increase the serial production of mechanical components of automation, lower their costs, and improve their quality and applicability. These steps can be taken only under socialism. Competitive struggle in capitalist countries leads to a great diversification in models of functionally similar devices and machines.

The influence of capitalist industrial relations upon the implementation of automation is very obvious when it comes to utilizing the possibilities of electronic computers. In some capitalist countries calculating machines are fairly widely utilized for automation of office work, such as for accounting purposes, economic calculations, etc. However, these machines are not used for operations beyond the framework of individual businesses, at best, they are utilized in the operations of monopolistic groupings. Socialism will create much greater opportunities for the utilization of these machines. The use of computers in a state-wide system of accounting, statistics, control, planning and management of the whole national economy of a country will result in an immense saving of manpower and equipment which is feasible only under socialism.

Workers, engineers and technicians of enterprises and construction projects of Moscow, Leningrad, Gorkiy, Zaporozhye, and Dnepropetrovsk Oblasts, as well as of the Byelorussian SSR, resolved to raise their socialist committments by means of broad introduction of new techniques in mechanization and automation and by reconstructing and enlarging existing plants without any increase of capital investment and to complete ahead of time, achieving by 1963-1964, the level of industrial production originally scheduled for 1965. The Central Committee of CPSU approved this valuable initiative.

In other socialist countries the workers also contribute materially to the development of automation. In Czechoslovakia, for example, out of six substations in the distributing network of an electric power system which were changed to remote control, four were equipped with units built in accordance with the ideas of the innovators. Inventors among the workers of the Ostrava coal fields created automatic conveyor belts for underground transportation equipped with an automatic fire extinguishing arrangement. Before 1962 all the underground conveyor belt lines in the Ostrava coal fields will be similarly equipped. Factory employees invented and introduced into actual use in the foundry department of the "Grafostroy" plant in the city of Irzhikov an automatic molding machine, superseding 12 nonautomatic ones previously in use. In a group of chemical enterprises in the city of Przherov, innovators succeeded in automating contact apparatus as well as drying and absorbing chambers for the production of sulphuric acid by the contact process.

Workers of socialist countries, as distinct from their comrades in capitalist countries, are not afraid of automation. They do not fear that automation may deprive them of work, lower their earnings, or cause deterioration in their working conditions. On the contrary, they use maximum efforts to speed up automation. The broad, constantly developing, creative initiative of people at large widens the scope for introducing automation in socialist countries.

Thus socialism has all the possibilities to promote automation at a much faster pace than capitalism. This fact, by the way, is well understood even by representatives of bourgeois economic science. Paul Eintsig for example, expresses serious concern that communist propaganda may succeed in convincing people of the possibility of speedier development of automation, which moreover would not have harmful consequences as far as the interests of the working classes are concerned. The fears of Mr. Eintsig are, of course, hot unfounded. It is only necessary to make his reasoning somewhat more precise. It is not so much propaganda as actual facts which convincingly persuade workers of capitalist countries that socialism may develop automation very much faster than capitalism. It is proven by fact that automation under socialism is not only free from harmful consequences to the working class but, on the contrary, benefits it greatly in substantially raising the standard of living.

All-round automation of productive processes under socialism and the introduction in all branches of industry of completely automated systems will increase many times the productivity of labor. Public owned

industry will reach such levels that all necessary commodities will be produced in quantities which will satisfy fully the ever-growing requirements of society and its members.

Wide automation of production in socialist society fundamentally eases and improves working conditions, changes its nature, raises the cultural and technical level of workers, and creates conditions leading to the elimination of the distinction between intellectual and manual work.

In connection with the reduction of time spent at present for the production of material well-being, there will be a wide opportunity for combining employment in industry with activities in the fields of science, art, etc. Thereby the last traces of the old-fashioned division of labor will be eliminated.

Progress in technology leads towards the elimination of differences between the two existing forms of socialist ownership and towards their amalgamation in one form of public ownership, gradually changing agricultural occupations into just another form of industrial labor. All-round automation covering all forms of production will be a major factor in eliminating the existing essential differences between cities and villages.

Comrade N. S. Khrushchev in his report at the extraordinary 21st plenary congress of the CPSU said: "In the course of further development in socialist industry, resting upon a new material and technological basis and as a result of closer relations between schools and industry, a gradual process of erasing the substantial differences between intellectual and manual labor will take place. As people undergo an all-round development, work will become for them the most vital requirement. This will be furthered by a planned shortening of the working day and the improvement in working conditions. When automation will be introduced in all branches of industry and when man will become master of the machine, he will have to spend less time and effort for the production of commodities. Labor which is still occasionally hard and tiresome will change into a source of pleasure and joy of a healthy and well-rounded man." /See Materialy vneocherednogo XXI s"yezda KPSS, Page 87/.

Automation is one of the most important prerequisites for the solution of the fundamental economic problem of USSR. Even bourgeois public figures are beginning to understand this. For example, West German economist Bittorf, warning capitalist countries against underestimating the successes of the development of automation in USSR, writes: "Nowhere is the appearance of continuous automatic production processes so welcome and electronic control systems accepted with such profound satisfaction as in the Soviet Union. Judging from existing information, the creation of fully automated production capacities are much more energetically supported in Russia than in the USA. The Soviet Union sees the chances which are offered by the new technology." Chances are, according to the sound judgment of Bittorf, that the Soviet Union by concentrating its attention upon the development of automation will be able within a few years to exceed the economic strength of the West.

Victory in the economic competition between socialist and capitalist systems is principally connected with the level of productivity of public owned industrial enterprises. Lenin wrote: "Productivity of labor is, in the final count, the most important factor for the victory of the new social structure. Capitalism established a level of productivity unheard of under the system of serfdom. Capitalism can be finally defeated and will be finally defeated when socialism creates a newer and much higher productivity of labor." /See V. I. Lenin, Sochineniye, Vol 29, page 394/.

Automation is at present the most potent tool for a rapid increase in the productivity of labor. The rate of development of automation therefore is exceptionally important for the solution of the fundamental economic problem of USSR, for the victory of socialism in economic competition with capitalism, and for the creation of a communist society.

The victory of socialism in the economic competition with capitalism and the attainment of the economic level of the most developed capitalist country, the USA, is only one step in the building of communism. By overtaking the highest level achieved by capitalism, socialist countries will march ahead creating a new and most productive form of social labor. The foundation of this process is technological progress, above everything, the development of automation.

"The Congress considers", it is said in the resolution of the 21st Congress of the Communist Party of the Soviet Union based on the report by comrade N. S. Khrushchev, "That the determining prerequisite for the successful fulfilment of the seven-year plan and for the creation of the material and technological basis of communism is the broadest implementation of the new technique of complete mechanization and automation of industrial processes together with greater specialization and closer cooperation in all branches of national economy." /See Materialy vneocherednogo XXI s"Yezda KPSS, page 148/.

2. Development of Automation in the Countries of the Socialist Camp

Until quite recently economic competition between socialism and capitalism consisted in the competition between the Soviet Union on the one side and capitalist countries on the other. Ever since socialism ceased to be confined to one country and a world-system of socialist economy came into existence, economic competition between socialism and capitalism acquired the character of a competition between two world-wide systems. At present the socialist side of this competition is fepresented not merely by one country, but by a whole group of countries.

Economics is the main field upon which this peaceful struggle between socialism and capitalism is taking place. The results of this economic competition of two diametrically opposed social and economic systems will determine in our time the whole course of world development.

In the countries of socialist camp the most intense development of national economies is taking place. "A rapid pace", emphasized Comrade N. S. Khrushchev in his report at the XXI congress of the Communist

Party of the Soviet Union, "is the universal feature of socialism witnessed by the experiences of all countries of the socialist camp." /See Materialy vneocherednogo XXI s"yezda KPSS, page 148/. Industrial production in socialist countries increased five times by 1958 as compared to the rate of production in their territories in 1937. The gross national product of the USSR increased 36 times by 1958 compared to 1913. The Chinese People's Republic increased its industrial production during the period of 1950-1958 approximately 10 times. Industrial production in 1958 increased in Poland as compared with the pre-war level 5.5 times, in Czechoslovakia 3.3 times, in the German Democratic Republic by more than 2.5 times, in Rumania by nearly 4 times, in Hungary by more than 4 times, in Bulgaria approximately 9 times, in Albania 18 times, and in the Korean People's Democratic Republic industrial production increased 3.5 times as compared to 1949.

In the course of rapid development of the national economies, industry now acquired a predominant part in most countries of people's democracy. Poland, Hungary, Rumania, and Bulgaria became industrial agrarian countries with a well developed heavy industry. The Chinese People's Republic from an agrarian country is becoming an industrial agrarian country. In 1937-1939 the share of industry in the gross national product of both industry and agriculture was equal to 24.8% in Bulgaria, 23.2% in China, 47.4% in Poland, 28.2% in KNDR /Koreyskaya Narodno-Demokraticheskaya Respublika -- Korean People's Democratic Republic/ (1946), and 57% in Czechoslovakia. In 1957 this coefficient was already 68.3% in Bulgaria, 46.9% in China, 71.9% in Poland, 63.4% in KNDR , and 70% in Czechoslovakia (1956).

Socialism has already fully proved its colossal superiority over capitalism as far as the pace of development of industry is concerned. The volume of production in USSR in 1958 as compared with 1928 increased 28 times. Industrial development in USA in 1958 exceeded the level of 1928 approximately 2.5 times, in England 1.9 times, and in France 2 times. The average annual industrial rate of growth during the last five years (1954-1958) throughout the whole socialist camp was 11%, whereas in the whole capitalist world it was less than 3%. In per capita production, the world socialist system taken as one unit has already caught up with the capitalist system.

In this new stage of economic competition with capitalism the goal of the socialist world system is to achieve preponderance over the capitalist system in world industrial putput, to overtake the most developed capitalist countries in the productivity of communal labor and to exceed them in per capita production and to insure the highest living standard in the whole international sphere. This will be a world-wide historical victory of socialism in its peaceful competition with capitalism on the international stage.

The tremendous advantages of socialism over capitalism offer the socialist world system a chance to solve this historical task within the shortest period of time.

Even now the Soviet Union exceeds USA, which is economically the most advanced capitalist nation, not only in the rate of industrial growth but also in absolute figures of annual increase of the most important types of industrial output. As a result of completing the seven-year plan, the Soviet Union by 1965 in the absolute figures of production in some of the most important types of industry will exceed and in others will approach the present level of industrial output of USA. By that time the per capita and total production of the more important agricultural products will exceed the present US level. Making an allowance for the rate of growth of population in the USSR as well as in the USA some five years longer will be needed for the Soviet Union to catch up and overtake USA in per capita industrial production. By that time, and possibly sooner, the Soviet Union will achieve the first place in the world as far as both total and per capita production is concerned.

The communist party of China set a goal of catching up with England in the volume of production of the more important industrial products within approximately 10 years. In 1958 the rate of industrial production growth in the KNR /Kitayskaya Narodnaya Respublika -- Chinese People's Republic/ was 66% as compared to 1957. A further increase of 25.6% in 1959 is foreseen in the total value of industrial output as compared to 1958.

Czechoslovakia already occupies on a per capita basis, as far as coal production is concerned, the ninth place in the world, in the production of brown coal the second place, cast iron -- eighth place, steel -- seventh place, footwear -- first place, railroad freight cars -- second place, motorcycles and washing machines -- first place. In the production of equipment for the chemical industry on a per capita basis Czechoslovakia has caught up with West Germany and has overtaken the USA, in the production of metal cutting machine tools and press forging equipment Czechoslovakia considerably exceeds France and England, is on the same level as West Germany, and is only slightly behind the USA. By 1965 it is intended to increaseethe volume of industrial output in Czechoslovakia by 90-95% as compared to 1957.

As a result of this effort Czechoslovakia will exceed in per capita production England and West Germany, and in most of the basic types of industry, the USA, For example, in 1958 the per capita steel production reached 434 kg /kilograms/ in the USA, 415 kg in West Germany, 402 kg in England, and 324 kg in France, whereas in 1965 Czechoslovakia will produce 739 kg of steel per capita. In cement production Czechoslovakia will reach 604 kg per capita in 1965, whereas in USA the per capita production of cement was 315 kg in 1958, 362 kg in West Germany, 219 kg in England, and 318 kg in France.

In the German Democratic Republic the total industrial production will increase 88% during the period of implementing the seven-year plan 1959-1965 in the development of the national economy as compared to 1958. The productivity of labor in the nationalized industry will increase by 85% before 1965.

The Polish People's Republic plans to increase the industrial production volume by 80% by 1965 as compared to the 1958 level.

In Bulgaria the volume of total national industrial output will increase by 1965 as compared to 1957 three or four times. During 1959 it was anticipated that the volume of industrial production would increase 28% as compared to 1958. This increase alone is 2.5 times as large as the whole annual industrial output of capitalist Bulgaria in 1939.

The workers of the Korean People's Democratic Republic intend to complete their first five-year plan (1957-1961) in its main features within three years and to overtake in per capita production during the next few years Japan which is economically the most advanced capitalist country of Asia.

Thus, as shown in the report of Comrade N. S. Khrushchev at the 21st congress of the CPSU, a common line of economic and cultural development is coming into existence. Due to careful planning inherent in the socialist system, formerly backward countries leaning upon the experience and help of other socialist countries quickly make up for lost time and bring into line their economies and culture. Starting with a profoundly scientific and objective analysis of the processes and trends in developing a world-wide socialist system, Comrade N. S. Khrushchev advanced in his report to the 21st congress of CPSU the most important theoretical proposition which states that: "...Socialist countries, successfully utilizing the inherent possibilities of the socialist system, will more or less simultaneously pass into the higher form of the communist society." /See Materialy vneocherednogo XXI s"yezda KPSS, page 98/.

To exceed the most advanced capitalist countries in the productivity of labor and to create at a faster pace the prerequisites for transition into the second higher phase of communism -- those are the colossal, truly historical problems which today confront the world-wide socialist system and every individual socialist country.

In seeking a solution to these problems an exceptionally important part is played by technical progress and above all the development and introduction of automated industry. As it is noted in the resolution of the June (1959) Plenary meeting of CC CPSU, complete mechanization and automation of production processes represent the basic method for technical progress without which further rates of growth of productivity are not possible. It is obviously impossible to overtake the most advanced capitalist countries in productivity of labor without first overtaking them in the sphere of technical equipment and mainly in the field of automation of production processes.

What are the achievements of automation in socialist countries?

In the first socialist country of the world, the Soviet Union, automation is developing at a fast pace. The CPSU and the Soviet government give constant attention to the development of automation as the most fundamental, the most progressive, and the most effective line of technical perfection of national economy of the USSR.

The first steps in automation of production processes in the Soviet Union took place during the pre-war five-year plans. In 1932 the first automated hydroelectric power plant of 2,000 kw /kilowatt/ was put into operation in Yerevan. In 1936 and 1937 the first attempts at automation of a blooming mill were undertaken at the S. M. Kirov Combined Metallurgic

Enterprises at Makeyevka.

The first automated line in the Soviet machine building industry was designed in the Stalingrad Tractor Factory in 1939. This machine consisted of five machines which were employed for machining hubs of idler wheels for tractors and for pressing facings on them. In the same year in the Rosteel'mash factory /Rostov Agricultural Machinery/ the first automatic assembly line in the world was constructed for canvas belts of combines. This automatic line was serviced by four operators. To produce the equivalent quantity of canvas belts by means of manual labor would require 90 workers and nine times greater floor space. In 1940 two automatic machine lines were put into operation in the Moscow Automobile Factory. One of them was for the purpose of grinding piston rings and the other for wrist pins. Those were presumably the first automated lines in the world combining semi-automatic general purpose machine tools.

After the war the introduction of automation in Soviet economy was accelerated. Application was found for automation in various types of industry such as machine building, metallurgy, the power industry, the food industry, the chemical industry, in some installations of light industry, in transportation, and in communication. In machine building, for example, the first automatic line was built in 1945 for machining heads of cylinder blocks for tractor engines. In 1946 in the factories "Stankokonstruktsiya" and S. Ordzhonikidze a number of automated lines were completed, among them an eight station line for machining all holes in the butt end of a four cylinder engine block, an eight station line for machining all the openings of butt surfaces of an engine block, a six station machine for machining openings on butt sides of the engine block of the economy car "Moskvich", a 13 station line for machining openings on the lower surface of the engine block of the same car, a 16 station line for machining the sides of the block, and a 14 station line for machining lower surface and sides of the engine block.

An outstanding success of Soviet technology was the creating of the widely known automatic piston factory, one section of which went into operation in August 1951 and the second in 1954. The plant designed by ENIMS /Eksperemental'nyy Nauchno Issledovatel'skiy Institut Metalorezhushchikh Stankov -- Experimental Scientific Research Institute for Metal Cutting Machine Tools/ under the guidance of Academician V. I. Dikushin was the first automatic plant of its kind in the whole world.

During the fifth five-year plan (1951-1955) Soviet machine tool builders created more than 40 completely automatic lines as well as completely automated production centers, which were connected systems of automatic lines. In many enterprises scores of automated production lines were put into operation, utilizing available plant equipment. For example, an automated department of several automatic lines was created for manufacturing piston rings, another automated department for manufacturing connecting rods, and an automated department for producing spark plug bodies, which included 16 transfer machines, etc.

A very large part for further development of automation in the USSR

was played by the XX congress of the CPSU. In its directives were spelled out the basic objectives for automation of industrial processes in various branches of the national economy, as well as for production of technical components of automation. Thus, for example, the production of automatic and semi-automatic lines, as well as equipment for complete automatic plants or plant departments, was to be increased approximately five times, while the production of devices for controls and automatic regulation of technical processes was to be increased four times, etc.

After the 20th congress of the CPSU both the rates and volume of work on automation in the Soviet Union increased rapidly and continuously. Work has begun on the construction of numerous new plants for production of devices, factories for construction of building block type component machine tools, and of automated lines, as well as other factories specializing in the production of automatic equipment. Dozens of scientific research institutions and design and construction offices have been established for solving problems in automation. During 1956 alone 4,000 treatises, among them about 600 books and booklets, were published on various subjects connected with scientific fundamentals of automation in the USSR.

The scope of introduction of automation for the development of the national economy of the USSR, as outlined by the sixth five-year plan, was very extensive. This was rather openly discussed by many public figures of capitalist countries. For example, in the English newspaper Times, which can hardby be suspected of sympathies for the Soviet Union and for communism in general, wrote regarding the sixth five-year plan that "apparently it forecasts the application of automation on a far broader scale than it has ever been tried in the West." However, even these ambitious targets, as shown by the first two years of the sixth five-year plan, were met and exceeded as a result of the rapid technical development of Soviet industry. Therefore, the CC CPSU and the Council of Ministers of the USSR passed, in furthering the decisions of the 20th Congress of the Party, a number of enactments which provided for a further expansion in the production of various devices and equipment for automation. The overall figure for the production of devices for industrial control and other equipment of automation was to be increased ten times by 1959 as compared to 1955.

Some achievements in automation in the Soviet Union have outstripped the highest level of modern technology in capitalist countries by several years.

In the USSR for the first time in the world a unique self-adjusting system of automatic control of production processes was created. An industrial pneumatic extremum-regulator, the first of its kind in the world, was built and put into actual use. This regulator routed production processes in the most profitable way.

The Soviet Union has the lead in the creation of an automatic device for running trains. A special guiding mathematical machine, so-called "Avtomashinist", [an automatic engine man] is programmed and then guides a train under optimum conditions and better efficiency ratings than the

most experienced human engineer. The "Avtomashinist" was successfully tested in the Moscow railroad junction. Equipping locomotives with this type of automatic control results in fuel saving from 5% to 7% and increases the carrying capacity of railroads by about 15% to 20%.

A computer of continuous action was developed in the USSR to be used in the calculation of the optimum method for exploitating oil and natural gas deposits. This machine was the first of its kind in the world. It determines the most advantageous locations for boring wells, the extent of artificial flooding, helps to study the distribution of strata pressures, and of interrelations of individual wells, etc. The results of these calculations lead to a drastic reduction in the number of wells in a given oil field, permitting more advantageous locations and the selection of the optimum methods for development of oil deposits and resulting in the saving of hundreds of millions of roubles.

In its degree of automation, the automatic department of the First State Baarings Factory for mass production of bearings, which was put into operation at the end of 1955, has no equal in the world. The group of engineers who designed and built this department were awarded the Lenin prize. The English technical magazine "Metalworking Production" wrote, "The automated bearing plant in Moscow is the world's most advanced industrial enterprise of this kind." In the automatic department every operation is fully automated. This begins with the loading of blanks and ends with the packing of completed parts. The department produces 1.5 million high quality bearings in one year. As compared to non-automated production, machine and assembly time was cut down nine times whereas production per worker increased approximately 1.5 times.

The automatic device of I. G. Loginov for driving tractors and a system for automatic controls of blast furnaces, which involved the use of computers and was designed and installed in the Kuznetsk Metallurgic group of enterprises, etc., were the first of their kind in the world.

Of considerable interest from a technological point of view are the following installations built in 1958: an automatic factory for roller chains, an automated plant department for plowshares and mold boards for tractor-operated types of plows, a completely automatic line for machining railroad car axles, automatic transfer machines for producing gears and splines, dial type transfer machines, an automatic assembly line for electric motors, general purpose numerically controlled automatic transfer machines, etc.

In the USSR efforts are being made to introduce automation of industrial processes in every branch and type of industry. Considerable results were achieved by the Soviet industry in the development of automation in energetics, ferrous metallurgy, and machine building. Separate systems of automatic and remote controls were introduced in chemical, oil-refining, coal, light and food industries, and in a number of other industries.

For example, in various branches of industry of the RSFSR, 1,112 fully or semi-automatic production lines and 17 fully automated factories are already in operation. In the Soviet machine building industry by the

end of 1958, more than 260 large automatic and semi-automatic lines were in operation, not including specialized dial multistation machines and smaller units. More than half of the large hydroelectric power plants were changed to remote control. In 1958 more than 90% of pig iron and steel came out of mechanized and largely automated blast and open hearth furnaces. In the chemical industry work is in progress towards complete automation of the basic departments of synthetic rubber, alcohol, nitrogen, sodium, sulfuric acid, chlorine and tire factories.

The colossal problems such as the achievement of first place in total production volume, per capita production, productivity of labor, standard of living, and a greatly expanded construction of a communist society are no longer tasks that can only be envisaged in the remote future, these are practical problems to be solved within the next few years. These problems can be successfully solved only on the basis of the maximum utilization of the newest achievements in science and technology, of broad introduction of all-round mechanization, and automation of industrial processes.

In the target figures for the development of the national economy of the USSR for 1959-1965 it is pointed out: "It is necessary to pass from automation of individual units and installations to complete automation and the creation of fully automated plant departments, technological processes, and whole enterprises. /See Materialy vneocherednogo XXI s"yezda KPSS, page 199/.

In both ferrous and non-ferrous metallurgy the seven-year plan schedules the automation of 250 units of the mining industry, 114 blast furnaces, 177 open hearth industries, 45 rolling mills, etc. The average level for the industry of mechanization and automation will be brought up to 80% ensuring thereby an increase in productivity of not less than 50%.

In the chemical industry, it is intended to automate over 150 departments and production units of various kinds: nitrogen, synthetic rubber, plastics, artificial fiber, rubber, tires, etc. Synthetic rubber production will be fully automated as well as that of synthetic alcohol. By the end of the seven-year plan plastic production will be automated by 95% and artificial fiber production by 90%.

In the oil and natural gas industry, eight oil refineries will be automated. The processes of extracting and transporting natural gas and oil products are scheduled for complete automation. The productivity of labor meanwhile will increase 60%.

In the machine building industry in the course of the seven-year plan, no less than 1,300 automatic and semi-automatic lines are scheduled to go into operation. Automation will take care of 60% of the production processes in general machine building, and in the electric and instrument industry production processes will be automated by 60 to 70%.

In light and food industries over 10,600 automated conveyor lines will be introduced as well as over 50,000 machine units for packing various goods. In 109 beetsugar plants and 15 alcohol plants, basic processes will be automated.

Apart from the fulfilment of a general program of automation in all branches of industry, it is intended to create over 50 experimental and demonstrator enterprises which will embody the latest methods of all-round automation.

The Gor'kiy automobile factory will be such an experimental and demonstrator plant. In this model plant, 136 automatic and semi-automatic lines will be put into operation and over 20 km /kilometers/ of conveyors and 1,400 special component machine tools, etc. will be installed.

The Moscow City Sovnarkhoz plans to carry out during the seven-year plan prototype all-round automation and mechanization of the most important industrial processes in 27 enterprises and in 139 plant departments and production areas of heavy, light and food industries. Thus, the Likhachev Automobile Factory in Moscow will be made into a fully automated enterprise. The number of automated lines in this plant will be increased from 9 to 172 and about 10 km of conveyors will be equipped with programmed controls for the automatic distribution of parts to work centers. In the First Bearings Factory, five automated departments will be constructed. The collective group of workers of this factory are undertaking to change to automatic production within the next three years 50% of their total output.

The seven-year plan provides for thorough automation and mechanization of 23 existing plants and 190 industrial departments and sections in factories of the Leningrad Sovnarkhoz.

During 1959-1965 in the coal industry controlled by the Stalino Sovnarkhoz all-round automation and mechanization will be carried out in 103 of the most important mine pits.

In Kuzbass it is intended to fully automate 36 mine pits and 15 concentrating mills and to introduce automatic and remote controls in over 10,000 various electromechanical installations.

In ferrous metallurgy all-round mechanization and automation must be carried out in Magnitogorsk, Kuznetsk, Nizhne-Tagilsk combined enterprises and in the Dzerzhinskiy Factory. This will ensure the additional output of approximately 900,000 tons of pig iron, 1,200,000 tons of steel, and 930,000 tons of rolled stock a year.

In the Sverdlovsk economic region all-round and thorough automation of two electric power plants, three blast furnaces, three open-hearth furnaces, five concentrating mills, 20 departments and 70 production sections are being planned. Over 500 new automatic and semi-automatic mass production lines will be created.

The workers of the chemical industry in Tula Oblast undertook to switch from creating individual automatic departments to fully automated factories. With this purpose in mind, coordinating electronic machines are being introduced in chemical plants. Thus, within the next few years the whole Yefremov Factory will be controlled automatically, and completely automatic enterprises will appear in the Stalinogorsk combined chemical and other enterprises.

Such examples are quite numerous. They all witness the rapidly progressing growth of automation in the Soviet Union and the fact that the important problems set by the 21st congress of the CPSU in the sphere of

automation will be successfully solved.

The decisions of the June 1959 plenary meeting of CC CPSU are of paramount importance for the fulfilment of these tasks. This meeting worked out a detailed program for accelerating the rates of technical progress in industry and construction.

The development of automation must be accompanied by advances in technology and in the organization of industry, by changes in design of products, by progress in standardization and unification, by a deep and complete growth in specialization and cooperation, and by further concentration of industries in similar types of production. Experience shows that only when these conditions are met will automation produce the most striking economic effect. In many instances only basic changes in technology, transition to a more progressive form of production organization, and such similar steps make it at all possible to introduce automation. The mere addition of a few gadgets to the existing technology, equipment, and production organization does not add up to automation.

The plenary meeting of CC CPSU emphasized the tremendous importance of all-round automation and mechanization as the basic tool for technical development and defined, at the same time, the concrete tasks for reconstruction, expansion, and technical re-equipment of existing enterprises. It also suggested introduction of new technology, further development of specialization and cooperation in national economy, increased emphasis on the part played by science in technical processes, and the earlier implementation of scientific discoveries in industry.

With regard to measures for all-round automation which are indicated in the resolution of the plenary meeting, it is necessary to pay particular attention to the following steps:

Long-term plans for all-round automation of various branches of industry, construction, and transportation.

Increase in the manufacture of various devices and equipment needed for automation, especially for specialization of enterprises and standardization of manufactured equipment, assemblies, and details.

Expansion of scientific research organizations and experimental and design organizations working in areas of all-round automation of production processes and providing opportunities for field experimentation.

Carrying out a unified technical policy to increase coordination of efforts towards the development of equipment and devices for automation.

The plenary meeting of CC CPSU paid particular attention to the fact that in USSR exist all the necessary prerequisites for the successful completion of the planned program for a further rise in the technological level of industry. The main task at present is to speed up organizational efforts and provide leaders in party work and economy guidance for the job of implementing advanced technology and to meet the new challenges.

The development of automation during the seven-year plan will be the greatest step ahead for future all-round automation of all the national economy of the USSR. N. S. Khrushchev emphasized in his report to the 21st congress of the CPSU the need "...to organize during the next few years on a mass scale the highly specialized production of modern equipment

for automation, so that in the future it will be possible to carry out the all-round automation of all the branches of the national economy." /See Materialy vneocherednogo XXI s"yezda KPSS, page 247. The USSR therefore is the first country in the world which sets up the task of carrying out all-round automation of all branches of the national economy. This is quite natural. This gigantic task can only be assumed by a country building a communist society.

In other socialist countries initial successes have already been achieved in areas of automation.

Beginning in 1951 in every new large and medium hydroelectric power plant in Czechoslovakia all-round automation is being introduced. By 1958 complete automation was carried out in hydroelectric power plants representing 50% of the total capacity. In thermal electric plants automatic regulation of fuel for boilers was carried out by the end of 1957 by 90%, and automatic control of burning in boilers by 52% of total steam generating capacity.

By 1960 in ferrous metallurgy 70% of the blast furnaces and 60% of the open-hearth furnaces will be equipped with a fully automatic thermal control system. Work is being carried out on the automation of charging blast furnaces. During the last few years a few partially automated blooming mills were built. By the end of 1958 in the Gottwald combined metallurgic enterprises a completely automatic blooming mill of a continuous action type, meeting all the requirements of modern technology, was put into operation. In the light metal industry there are automatic units for the production of screws, bicycle spokes, spiral springs, etc.

In the chemical industry complete automation was introduced in the production of butanol. A high degree of automation was also achieved in the production of synthetic gasoline. Partial automation was introduced in some plants for the production of sulfuric acid, superphosphates, nitrogen fertilizers, and plastic goods. In the rubber industry there are several automatic production lines, two of which are on the highest level of world technology. One of these lines produces soles for shoes and the other rubberizes fabric.

In machine building, mainly in automobile plants, a number of automatic units and automated lines for machining, welding, heat treating, coating, and other industrial operations were introduced. In 1958 alone 220 mass production lines were put into operation. This number included one automatic machine line on an automobile plant in the city of Mlada Boleslav, one automatic line on a truck plant in the city of Koprzyvnica and one on a motorcycle plant in the city of Strakonice. The Czechoslovakian machine building industry developed the technology for the production of automatic machine tools for various purposes, building block type of machine tools, automatic machine lines, machine tools with programmed controls, and also various devices and other equipment for automation. Also were developed calculating machines of digital and analog types.

In the coal industry of the Ostrava basin by the end of 1958 approximately 400 conveyor belts for underground transportation were automated. A measure of success was achieved in the automation of

drainage and elevating equipment. Some new coal concentrating plants were also partially automated.

Some successes were also achieved in the automation of enterprises of light and food industries, in the building material industry, in railroad transportation, and communications.

These however are only preliminary steps. In spite of some successes, automation in Czechoslovakia has not become sufficiently widespread to render a decisive influence upon labor productivity.

The 11th congress of the Communist Party of Czechoslovakia emphasized the need for future achievements of a qualitatively higher level of technical development and of changing over to complete mechanization and automation of production processes. The congress resolved that higher development of production capacities on the basis of advanced technology, particularly automation, is one of the basic steps towards the completion of socialist construction and the creation of the prerequisites for the transition to a communist society.

The third five-year plan (1961-1965) provides for a considerable acceleration in technological progress. The directives of the third five-year plan for development of national economy set this goal: "Push ahead automation of technological processes, controls, and laboratory research, and create concurrently the necessary prerequisites for gradual transition to complete automation of individual departments, production enterprises, and factories." /See Rude pravo, 29 zari 1959/ Automation will be introduced initially in energetics, metallurgic and chemical industries, machine building, production of building materials, light and food industries, transportation and communications.

For example, in the electric power industry it is intended to increase automatic control of fueling boilers in thermal electric generating plants to 97% and the automatic control of the burning process to 86% (both on the basis of steam generation). Also to complete automation of all hydroelectric power plants and to change to remote control all the hydroelectric power installations on the cascades of the Vltava and Vah Rivers.

In machine building it is planned to introduce scores of new automatic machine lines, 12,000 automatic and semi-automatic machine tools, among them 7,500 machine tools with programmed control for automation of short and medium production runs, about 1,000 automatic and semi-automatic welding units, etc.

Along with further acceleration in introducing automation in the main branches of industry, it is intended to set up model experimental production plants and factories completely mechanized and automated and equipped in accordance with the most advanced technology, which will become stepping stones for the further development of automation on an industry-wide basis.

During the third five-year plan prerequisites are systematically developed for transition at a future date to complete mechanization and automation covering the whole range of the national economy in Czechoslovakia.

In the German Democratic Republic a lot of attention is being given to the acceleration of technical development in the national economy. The third conference of the Socialist Unity Party of Germany set a goal of starting a systematic and planned conversion in industry during the second five-year plan (1956-1960). In the directives of the third conference of the Socialist Unity Party of Germany it is pointed out: "The second five-year plan is the plan which stands under the sign of decisive progress of technology and considerable growth in productivity in all branches of the national economy." /See "Neues Deutschland", 1 April 1956./

For example, in 1960 the production of metal cutting machine tools as compared to 1955 increased 2.3 times, whereas the production of automatic and semi-automatic machine tools increased 7.5 times. The plan for 1956 alone provides for the creation of 28 mass production and automatic process lines in the GDR industry.

The slogan "modernize, mechanize, automate" advanced by the Party to the working class of the GDR is being successfully fulfilled. In the metallurgic industry automatic heat control of both blast and open hearth furnaces is being introduced. Before 1960, for example, the heating systems of all open hearth furnaces in the metallurgic combined enterprises in the city of Riesa will be fully automated. Blast furnaces Nos. 5 and 6 of combined enterprises in the city of Stalinstadt will be equipped with a system of automatic loading. An important part in the metallurgic industry of the GDR will be played by the system of automatic loading and controlling of low stack furnaces which is being introduced in the cities of Halberstadt and Calbe. This system permits a sharp increase in the efficiency of labor in the low stack furnace production of pig iron. In the combined metallurgic enterprises of Calbe alone the introduction of this system helped to reduce the labor force by 225 and to increase the productivity of the furnaces by 30%.

The machine tool industry of the GDR has successfully adapted itself to the production of automatic machine tools for various purposes, special and building block types of machine tools, multistation ones, automatic transfer machines, machine tools with programmed control, and multistation automatic presses. A number of automated lines are already in operation in the machine building factories of the German Democratic Republic. For example, the automobile factory "Sachsenring" in the city of Zwickau has a fully automated transfer machine for manufacturing cylinder heads. This machine consists of two main parts, one for milling and one for drilling operations. In the factory for motorcycles in the city of Zorbau two automatic transfer machines were put into operation for machining of the right and left sides of engine blocks of motorcycles. Automatic transfer machines are used for manufacturing tracks of tractors, parts of sewing machines, and the production of screws, springs, bearings, etc.

In the shoe-making industry of public-owned enterprise "Banner of Peace" in the city of Weissenfels an automatic conveyor line for the production of soles was put into operation. The maximum output of this

conveyor line reaches 8,000 pairs every 24 hours. On the "Zeiss" plant in Jena the first electronic computor in GDR was installed. Automation on a large scale is also used in the electric power industry, chemical industry, some production processes of light industry, food industry, railroad transportation, and communications, etc.

The seven-year plan for the development of the national economy of GDR for 1959-1965 is intended as a plan for the completion of socialization of the German Democratic Republic and provides for sharp acceleration in the rates of increase of labor productivity, which on the average must increase annually by 9% to 9.5%. This can be achieved only on the basis of the broadest introduction of latest technology and reconstruction and re-equipment of basic branches of industry by means of catching up and then overtaking the highest level of world technology. "To achieve the level of technology equal to the world's best" stated Walter Ulbricht, the first secretary of TSK of the Socialist Unity Party of Germany, in his report to the VI plenary session of CC of the Socialist Unity Party of Germany, "all-round mechanization and automation of decisive industrial processes is imperative". /See "Neues Deutschland", 22 September 1959/ The seven-year plan sets the concrete tasks for further acceleration in production of the devices and equipment of automation.

In various branches of industry, more than 450 fully automated departments and production centers will be created and 375 automatic processing machines put into operation. In the electric power industry it is planned to change to remote control 138 substations and hydroelectric plants. In the chemical industry, along with the broad automation of plants for production of synthetic gasoline and nitrogen fertilizers, the basic production processes in 134 additional enterprises will be mechanized and automated. In a glass factory in the city of Friedrichsheim a complete automation of the production of television tubes is planned.

In the Chinese People's Republic an industrial revolution is rapidly developing. People's China is moving fast to the summits of world technology. Already some definite successes were achieved in automation of industrial processes and considerable attention is given to the creation of the necessary scientific, material and technical conditions for making the transition to introduction of automation on a wide scale at a later date. It is known that in the study of scientific theory of automation China has realized sizable results. Chinese scientists achieved considerable results in their studies of cybernetics, the semiconductor technology, and some branches of radio electronics.

The Chinese machine building industry, leaning upon the brotherly help of the Soviet Union, successfully mastered the production technique of many types of automatic equipment, automatic metal working machine tools, devices, and other equipment for automation. Also several types of electronic rapid action computors of digital and analog type were built. The large Chinese metallurgic factories built during the last few years and those at present under construction are furnished with the most up-to-date automatic equipment.

The Lanchow chemical factory, one of the greatest enterprises being built in China with help from the Soviet Union, is equipped in accordance with the most advanced modern technology. The department of chemical fertilizers recently put into operation is automated to a very high degree. The English magazine Tooling, devoted to machine building, reports that in Chinese industry automatic production lines with electronic programming equipment are used. In accordance with the evaluation of the magazine, the system of programming of machine tools and machine tool groups is used far more extensively in China than in England.

The machine building factories of Poland during the six-year plan (1950-1955) put into operation the first automated lines: the automated line for machining cylinder heads for the motor "Warszawa" in the automobile factory in the city of Zeran, the automated line for machining the engine block of the engine "Star" in the truck factory in the city of Starachovica, and the automated line for machining the bodies of electric motors in the factory in the city of Tarnov. Two of the automated lines were designed and built by Polish machine tool builders. During the six-year plan the machine building industry also mastered the facilities and skill for the production of automatic and semi-automatic machine tools. By the end of 1960 it is planned to increase the volume of production of automatic and semi-automatic machine tools 7.5 times.

In 1958 in the Institute of Applied Mathematics of the Polish Academy of Sciences the first electronic computer in Poland was developed. The Polish instrument-making industry is rapidly developing. Some successes in implementation of automation are being achieved in energetics, metallurgy, food, and coal industries. For example, in the mine pit of "Vuek" (Katowice Wojewodztwa) an automatic dispatcher was designed and built by Polish engineers and installed. It ensures complete control over all units of the coal mine galleries and drifts. In the chemical industry some enterprises for the production of organic synthetic materials were partially automated in the group of combined enterprises in the cities of Tarnov, Oswiecim, and Kendzierzin.

Automation is beginning to enter the picture in the national economy of Bulgaria first of all in their power, chemical, and food industries. By 1960 complete automation will be carried out on hydroelectric power plants representing 62% of rated power of all hydroelectric power plants in Bulgaria. The thermal power plant "Maritsa Istok", currently under construction, is already the largest in Bulgaria and when completed will be the largest on the whole Balkan Peninsula. It will be fully automated and controlled from one central control board. In 1959, in the canning industry of Bulgaria, 12 automatic processing lines for canning tomatoes and four automatic processing lines for canning fruit will be installed.

The Bulgarian Communist Party displays great concern in the speeding up of technical progress. Comrade Todor Zhivkov in a report of the CC of the Bulgarian Communist Party to the Party's VII Congress said, "Now when our socialist industry has grown considerably and become stronger, our problem will be the acceleration of technical progress and this will

be the task confronting the ministries, party and economic agencies, and leaders and personnel of industrial enterprises. This is a problem of paramount importance." /See T. Zhivkov, Otchetnyy doklad Tsentral'nogo Komi teta Bolgarskog kommunisticheskoy Nortiz VII s"yezda partiz - Report of Central Committee of the Bulgarian Communist Party to the Party's VII Congress/, Moscow, 1958, page 51./

The plenary meeting of CC of the Bulgarian Communist Party which took place in July 1959, appealed to all party committees and organizations with a letter in which it pointed out: "...in a number of branches of the industry, such as the power industry, the electric industry, the chemical and machine building industry, a more decisive attitude must be assumed towards the introduction of automatic and semi-automatic production lines, remote control systems, and other more advanced forms of industrial organization. /See "Rabotnichesko Delo", 11 July 1959/

In the Rumanian People's Republic a lot of attention is being paid to the introduction of automation in ferrous metallurgy. In metallurgic combines in the city of Hunedoara three large newly built blast furnaces are equipped with automatic control systems which regulate temperatures, pressures, and moisture. The loading is carried out automatically. The open hearth furnace department, presently under construction, will be provided with automatic equipment and temperature controls. Partly automated are ore dressing, coke-chemical plants, and a blooming mill. In the combined metallurgic enterprises in the city of Resicza soaking pit furnaces in the rolling mill department have been automated. A high degree of automation is displayed at the pipe factory in the city of Roman.

Ever wider automation is used in the electric power industry. Already automated controls are introduced in four groups of hydroelectric plants and automatic controls of burning processes were installed in 33 boilers of thermal electric power plants. Since 1950, automation is being introduced in the electric network. Automation and remote control systems for electric substations are in the design stage.

In the chemical industry some newly constructed units are automated, such as the departments for the production of ammonia and nitrogen fertilizers in the combined chemical enterprises of the city of Orasul Victoria. A study is being carried out on the automation of a sulfuric acid factory and a factory for the production of calcinated soda.

In 1957 in the machine building industry the first automatic machine line in the truck factory "Krasnoye Znamya" was put into operation in the city of Stalin. This special automated line is for machining engine blocks. In the future, automatic lines will be introduced in the production of tractors, trucks, and electric motors.

Rumanian scientists and technicians created a high-speed electronic computer capable of performing 15,000 operations a second.

In Hungary some results in the area of introducing automation were initially achieved in the electric power generating industry, in the chemical and metallurgic industries, in railroad transportation, and communications. The Hungarian instrument industry is rapidly developing and has already acquired skill and facilities for the production of

a wide selection of modern equipment for automatic controls and regulation.

It is characteristic for the present state of economy in countries of socialist camp that maximum attention is being concentrated upon expediting technological progress aimed at reaching and exceeding the summits of world technology. As the countries of the socialist camp bring to a common level their economic and cultural development, they likewise bring to a common level the technical development of national economies. Thus, formerly backward countries rapidly catch up with technically advanced countries. This objective process is speeded up by the automation of industry.

3. Brotherly Cooperation and Mutual Help Between Countries of Socialist Camp are an Important Condition for Successful Development of Automation

Construction of socialism and communism in the Soviet Union and in the countries of people's democracy is furthered by an evergrowing fraternal cooperation and mutual assistance of the countries of socialist camp. This fact ensured in all countries of the world system of socialism a fast rate of economic development. "Alone and on its own no country could develop such a rapid growth of industry as in the system of socialist states", stated N. S. Khrushchev in his report at the XXI convention of the Communist Party of the Soviet Union. /See Materialy vneocherednogo XXI s"yezda KPSS, page 60/

Socialist industrial relations and public ownership of the means of production are the foundation of a rapid development in the economies of all countries in the world socialist system. Economic cooperation of countries of the socialist camp which develops on this foundation presents a completely new type of international economic relations.

Economic relations of socialist countries, founded upon the economic laws of socialism, exclude competitive struggle inherent in capitalism, chaotic conditions of industry, suppression, enslavement, and exploitation of weak countries by more powerful ones. The mutual relations of socialist countries are based upon principles of complete equality, respect for national interests, state independence and sovereignty, and socialist mutual aid. The economic success of each individual socialist country is a contribution to the common development to the whole world system of socialism and a foundation for further strengthening and expansion of relations between all socialist countries. Formerly economically backward countries, leaning upon the experience of other more advanced socialist countries and upon their help and cooperation, quickly overcome their backwardness and bring in line their economies and cultures.

Mutual assistance and brotherly cooperation are the most important characteristic features of economic relations between socialist countries. Nothing proves better the unconquerable unity of the socialist camp and the embodiment of principles of proletarian internationalism than the developing, strengthening, and perfecting of economic relations of countries which liquidated their capitalist economic system.

For the purpose of developing and strengthening cooperation between socialist countries, a Council of Economic Cooperation was organized in 1949 represented by the Soviet Union, Albania, Bulgaria, Hungary, the German Democratic Republic, Poland, Rumania, and Czechoslovakia. Representatives of the Chinese People's Republic, the Korean People's Democratic Republic, Vietnam Democratic Republic, and the Mongolian People's Republic participate in the work of the Council as observers.

During the first post-war years economic relations between socialist countries developed mainly along lines of external trade. Originally the agreements on commodity circulation were closely related to the historical structure of the foreign trade of each of the socialist countries and were signed on a year-to-year basis. But as the world socialist market gained strength, a transition took place towards long-term agreements. This helped to coordinate economic development plans of socialist countries.

At the same time scientific and technological cooperation progressed, and played an important part in the economic development of socialist countries particularly in connection with the improvement of their production technique. This cooperation is carried out in a number of ways, such as the release of patents and technical specifications, cooperation in the training of personnel, mutual exchange of industrial and technical experiences, joint development and utilization of natural resources, direct cooperation of scientific research institutions and designing organizations of individual countries, etc.

In the framework of scientific and technical cooperation, the Soviet Union handed over to Czechoslovakia without compensation designs of factories for producing aluminum and synthetic rubber, tube rolling mills, open hearth furnaces, ball bearings, technical specifications for coal mining combines, grain combines, and other machines, also specifications for a new method of concentrating non-ferrous ores, etc. On their part Czechoslovakia handed to the Soviet Union technical specifications for producing presses, tanning equipment, shoe-making and textile machines, diesel engines, railroad cars, medical instruments, concrete construction, etc.

In the beginning of 1958 in socialist countries with help from the Soviet Union over 500 industrial enterprises were built or were under construction.

In turn, Poland, for example, delivered to the USSR complete equipment for four sugar refineries and ten plants for lightweight concrete. The GDR delivered complete equipment for seven cement factories and 23 sugar refineries.

It is a peculiarity of the economic growth of socialist countries, as was pointed out by 21st congress of the CPSU, that as their economies progress so their mutual relations become closer and stronger and the world socialist system becomes more and more united. This is a manifestation of the historical tendency towards "...the creation of a unified world-wide economy, regulated in accordance with one common plan by the proletariat of all nations. This tendency already became quite apparent under capitalism and will, without doubt, continue to develop and will reach its completion

under socialism." /See V. I. Lenin Soch, Vol 31, page 125/

A further rapid rise in the economy of each socialist country, as well as the further development of economic cooperation between them, is connected with the transition from indirect coordination of plans for development of the national economies of the members of world socialist organization by means of long-term trade agreements to direct coordination of plans for economic development in these countries. During the last few years a problem of finding the most rational solution for utilization of natural resources and industrial capacities of each individual country and the whole socialist camp was being studied. The solution is to be found in the coordination of various branches of national economies and through specialization and cooperation in industry. This signifies a new and higher stage in economic cooperation between countries of the world socialist system and is an important step forward on the way to the systematic development of a new socialist international division of labor.

A conference of representatives ffom communist and workers' parties of countries participating in the Council of Economic Mutual Assistance, which took place in May 1958 in Moscow, emphasized that economic connections between socialist countries grew considerably in strength and became all-embracing in nature. Further development and improvement in economic cooperation between these countries and greater specialization combined with more cooperation gain particular importance. Correct organization of the cooperation and specialization of industries within the socialist camp ensures savings in material resources and increases the level of productivity of social labor, as well as the more rational utilization of natural resources and economic prerequisites existing in socialist countries which will make it possible to increase the rate of production on an expanded scale.

During the last few years in the sessions of the Council for Economic Mutual Assistance steps to be taken for the fulfilment of previously set tasks were discussed. Considerable work was done in the coordination of plans for economic development in socialist countries in 1965. Work was commenced for the purpose of coordinating long-term plants for developing the main branches of the national economies of countries participating in the consultations covering the period extending to 1975. Particular attention in the work of coordination is being paid in the first place to the development in every way possible of raw materials in the national economies, thus ensuring complete satisfaction of the growing needs of rapidly increasing industries of the socialist countries, secondly to the development of specialization in industrial units and cooperation between various units of manufacturing industry, with particular emphasis on the machine building industry. The need for further substantial increase of both cooperation and specialization is due to the fact that this will present opportunities for a sharp rise in serial and mass production, which in itself is a prerequisite for the achievement of a high technological and economic level of various branches in the manufacturing industry. This will be a stepping stone for the effective introduction of automation in production processes on a broad scale.

Automation of production is inseparably linked with the further development and broadening of the international division of labor. Historically there was always a connection between the division of labor in a given community and the productivity of labor. Being qualitatively a new phase in industrial technology and representing a technological revolution and a new stage in the development of productive forces of society, automation heavily accentuates the historical tendency, noted by V. I. Lenin, towards the creation of world-wide economy as one integral unit, the breaking down of national and state borders, and the creation of international unity in economic life.

The increase in the objective tendency towards the establishment of world-wide economy as one unit represents a commonly observed phenomena in both socialist and capitalist countries. This tendency is expressed by the world capitalist system in all kinds of plans such as the "integration" of Western Europe, attempts to create a "common market" of six West European countries, a "small zone of free trade", "Euratom", etc.

Nearly all the defenders of various plans for "integration of Europe" use automation of industry as their main argument. In most of the capitalist countries the expansion in the introduction of automation is directly connected with one or another form of "integration". For example, during one of the conferences on the subject of automation, which took place in the city of Alpbach in September 1956, the Austrian Minister of Finance, Prof Dr Kamitz, said that the "internal market of most of the European countries is too limited to absorb the whole volume of production of enterprises which have changed to automation. There will be no desire to invest capital in automation if a stable market, the size of Europe, is not found. Politically speaking it means that there must be a long-term goal of integration and the creation of a common market for all the goods produced by Western Europe."

Under capitalism, however, this tendency towards the creation of unified world economy constantly runs into a narrow framework of capitalist industrial relations, which are based upon private capitalist ownership of industrial facilities. Therefore this tendency under the bourgeois system cannot find its proper realization. This is witnessed by attempts made over a period of many years to create various plans for "integration." The establishment of a world-wide system of economy is possible only under conditions of socialism, on the basis of public ownership of means of production.

Under capitalism the international division of labor is carried out by means of coercion and compulsion, by means of fierce competitive struggle, by means of pitiless enslavement of the weak by the strong, and is aimed at the preservation of backwardness in underdeveloped countries, colonies, and semi-colonies. Introduction of automation under the conditions of capitalism will inevitably lead to an ever increasing lag between small countries and great powers, a growing gap in the economic levels of underdeveloped countries and great imperialist states, and increase in dependence of small and underdeveloped countries in relation to powerful ones and further accentuation of irregularity in

the development of capitalism.

In the countries of the socialist camp, on the contrary, the division of labor is based upon relations of voluntary alliance, brotherly cooperation, and mutual help of socialist countries to each other. Socialist system of world economy creates all the necessary prerequisites for the fastest introduction of automation in all the countries belonging to this system. Introduction of automation under conditions of socialism accelerates the liquidation of economic backwardness in some socialist countries which is a carry-over from the former capitalist system, speeds up the growth of their economies, and leads towards the creation of a common economic level in all countries of the socialist camp.

If development of automation in one or another of the capitalist countries leads towards the increase of competitive struggle, further aggravation of contradictions between countries of the capitalist system, and to a clash of interests, the successes in introducing automation in any socialist country become a contributing factor to further development of economic cooperation and for a general rise in the technological and economic level of the whole world system of socialism.

During the ninth All-German Workers' Conference, which took place in March, 1959, in the city of Leipzig, Comrade N. S. Khrushchev said: "Between the sovereign countries of the socialist camp a broad collaboration develops in all areas of economic, social, political, and cultural life. If we want to digress into the discussion of the future, it seems to me that the further development of socialist countries will, most likely, follow the path towards the strengthening of one united world system of a socialist economy. One by one the barriers which separated our countries under capitalism will be removed. The common economic basis of world socialism will strengthen, eventually making the whole problem of borders rather pointless." /See Pravda, 27 March 1959/

With the development and the strengthening of the world economy in the socialist system, the economies of the countries concerned become more and more interrelated. Introduction of automation leads towards further strengthening of economic links between socialist countries, towards a further powerful socialist international division of labor, and towards broader development, specialization, and cooperation of industries in socialist countries. It is entirely clear that the plans for accelerating technical development in individual socialist countries cannot be evaluated independently from the rise of economy of the whole socialist camp.

In every socialist county a systematic preparation for a future material and technological basis of communism is developing. This development differs in its degree from country to country, but for all of them complete transition towards mechanization and automation of all branches of the national economy combined with thorough utilization of all potentialities of economic cooperation between the countries of the socialist camp as well as of socialist division of labor become an exceptionally important task. This is the necessary prerequisite for further rapid development of production forces on a level of the highest

technology. Only on this foundation can the long-term plans for rapid and broad introduction of automation in the national economies of all socialist countries become quite realistic.

The need for further development in the international socialist division of labor between the socialist countries by means of broad specialization and cooperation in industrial production is particularly urgent from the point of view of further development in the European countries of people's democracy. European countries of people's democracy belong to the class of medium and small countries. Notwithstanding the differences in the level of economic development, it is a common and characteristic feature of all such states that they possess a relatively limited internal market which causes low volume production of any given product leading, in the final breakdown, to short production runs and low development of mass production. Automation as it stands at present is a typical tool for mass production, and therefore, it is used with some exceptions only in long runs and mass production.

It was already mentioned in the first chapter of the book that the common tendency everywhere in the development of automation is to increase the flexibility of automatic equipment making it feasible to use it in short runs and even in single item production. At present, however only the first tentative steps have been taken in the direction of finding a funamental solution to the problem of flexibility in automatic equipment. Flexible automatic equipment, which possesses some degree of general adaptability permitting quick setups, is at present much more complicated and therefore much more expensive than automatic equipment for mass production. Besides, it becomes evident even today that when the fundamental solution to the flexibility of automatic equipment is found,it will become economically profitable only where the total volume of a single item or short run productions is very large.

For the a bove reasons in the medium-developed and little-developed capitalist countries of Europe automation is being introduced slowly and cautiously. The exceptions are the relatively few large and highly specialized enterprises, which also extensively export their products, such as the Italian automobile factory "Fiat", and some Swiss watch factories, etc. Even today, though automation in the whole world is still in its infancy, it becomes increasingly evident that the level of automation in smaller countries lags behind and the gap is increasing as compared to the level achieved by the great capitalist countries of the USA, England, France, and West Germany.

Introduction of automation in the national economies of small countries without doubt brings about the complicated practical problems connected mainly with the limited scope of domestic markets. However this is true only in relation to countries of the capitalist world. For countries of the world socialist system the development of automation is logical and economically sound. For socialist countries the problem is not whether automation should be introduced at all, but to find a solution for the problems of automation which would be best for the peculiar needs and potentialities of the national economy of a given country, and in finding ways of rapid introduction of automation on a

broad basis and with the greatest economic effect. Such a solution can be found only through the combined efforts of all countries of the socialist camp by further developing and improving all forms of economic collaboration on the basis of deeper specialization and cooperation between the industries of all socialist countries.

The rapid and broad introduction of automation in the national economies of European countries of people's democracy is the feasible, realistic and economically sound task, providing that the economy of each socialist country is not taken not as a separate entity, but as a part of the world socialist economy. Under the conditions of the new industrial revolution this is the only way to ensure in all socialist countries a further development of the national economy on the highest level of world technology.

From the experience of the machine building industry it is possible to determine the opportunities which are opened up by the international socialist division of labor, resulting in a substantial increase in mass and serial production, thereby creating the necessary conditions for the successful development of automation. Machine building is the principal and leading branch of industry of nearly all European countries of people's democracy. At the same time this particular type of industry clearly exposes all the complexities in the problems of introducing automation in a small country. It can even be stated that the center of gravity of all the problems of automation lies in the machine building industry.

In 1957 the machine building industry in all European countries of people's democracy, taken as a group, produced 70,000 metal cutting tools, whereas the total export of these machine tools between these countries was equal to 3,412 units, barely equalling 4.6% of the total volume of production. Likewise, the proportion of export sales as against the total volume of production in European countries of people's democracy was as follows: tractors -- 3.3%, railroad freight cars -- 7.6%, trucks -- 3.3%, automobiles -- 8.2%. These figures attest to the low state of specialization. Many similar types of machinery and equipment were produced in various people's democratic countries at the same time and mainly to satisfy the domestic markets. Mutual sales were strictly of secondary importance. The results of this condition were shortness of production runs, an excessively great number of models, and duplication in the production of virtually the same type of machinery. This is the basic reason for the condition that in the machine building industry of all the countries of the people's democracy there are only a few dozen automatic machine lines and some of them are of little importance economically.

To put a stop to this condition the Council of Economic Mutual Assistance developed a whole number of recommendations which, when put into effect, will mean a large step forward in the development of specialization and cooperation in the machine building industries of socialist countries.

A lot of work was put into the reduction of the number of models produced in the countries of socialism by means of eliminating unnecessary

duplication and simplifying the series of the same type. For example, it is recommended to cut down the number of models of coal mining equipment by 77% and cement machinery by 42%. In the metal cutting machine tool group the discontinuance of 42% of existing models is recommended together with the introduction of 24% of new types of machine tools never before produced in socialist countries. As a net result, the total number of models of machine tools will be cut down 18%. It is also recommended to abandon the production of 46% of the models of woodworking equipment and to introduce 16% new models, which will bring down the total number of models produced by about 30%.

In 1958, as a result of the further promotion of specialization, Bulgaria increased the export of machinery and equipment used in the meat industry five times and in 1959 ten or twelve times as compared to 1957. Specialization in production of grain combines will increase the length of production runs in Hungary 2.5-3 times. Taking into consideration the requirements of all the countries participating in the Council of Mutual Economic Assistance, Czechoslovakia will increase by 1965 as compared to 1955 the production of automatic and semi-automatic machine tools 9.3 times, special machine tools 35 times, and the building of block type machine tools 23 times. Due to these steps Czechoslovakia will occupy one of the first places in the world in per capita production of machine tools (9.5 kg). At present the first place in per capita production of machine tools is occupied by West Germany where in 1956 the per capita production of machine tools was 5.3 kg (in USA -- 4.5 kg.)

These are, of course, only the first but rather important steps in the direction of developing higher forms of international socialist division of labor. However, even these first steps prove clearly what colossal possibilities exist in the further development of specialization and cooperation for the growth of industry in the whole socialist camp and in every individual socialist country. This will lead to a rapid and successful introduction of automatic production in all socialist countries.

Until recent times the development of specialization and cooperation between countries of the socialist camp followed mainly the line of specialization in certain types of goods. Although there still exist in this direction tremendous unused possibilities, one must not forget that the eventual goal in the division of labor in accordance with V. I. Lenin's definition "consists of setting up as a separate branch of industry the production not only of each separate item, but of its every component, even going as far as assigning to special branches of industry each operation necessary for the completion of the item." /See V. I. Lenin, Soch, Vol 3, page 15_7 In the future it may be expected that many subassemblies and details, wooden items, tools, etc. will be made in large, highly specialized, and completely automated enterprises, which will serve the requirements of all socialist countries.

Further development of the international division of labor among countries of the socialist camp is not only the prerequisite of a substantial increase in serial and mass productions, but the necessary conditio

for a highly effective introduction of automation on a large scale. It also serves as the prerequisite for ensuring rapid progress in automation in individual socialist countries by ensuring the supply of the necessary instrumentation, machinery, and other technical means.

At present the machine building industry of the socialist countries successfully developed the production technique of many kinds of automatic equipment, devices for automatic controls and regulation, electronic computers, etc. However, even today the production of equipment for automation obviously lags behind the needs of the national economies of socialist countries, both in assortment and quantity of production. In most of the socialist countries, therefore, it is planned to increase sharply the production of the technical means of automation. The 21st congress of the CPSU set the task of organizing in the USSR within the next few years mass production in the highly specialized industry of modern equipment for automation. The production of devices and other means of automation is rapidly increasing in the German Democratic Republic, Czechoslovakia, China, Poland, and Hungary.

It would be a mistake to assume that every individual socialist country by the means of automation will be able to satisfy all the needs of its national economy. Automation may develop rapidly only when its components are not made to order but are mass produced. The necessary material for the rapid development of automation on a nation-wide scale in socialist countries can only be achieved as a result of the most thorough-going division of labor among countries of the socialist camp, on the basis of a broad and systematic exchange of experiences, and on the basis of specializing both research and industrial production in individual countries, taking into consideration local conditions, requirements, and opportunities.

As a long-term project it would be worthwhile to begin to unify and standardize the most important subassemblies of automatic equipment, which are used in various branches of industries, to utilize widely the block principle when designing automated units, and on this basis to create for the whole socialist camp a uniform system of units, arrangements, and schemes for automation. The unified system of automation which is being developed at present in the USSR can well be used as a foundation for this work. It would bring to all countries of the socialist camp a considerable saving of material and manpower, would lead to maximum utilization of the available industrial capacities and scientific and technical forces of individual countries for speeding up general progress, and would permit acceleration in the introduction of automation and broaden its application.

An exceptionally important part the rapid and successful development of automation in the countries of people's democracy will by played by the maximum utilization of the rich experience of the Soviet Union. In the Soviet Union work on automation is conducted on a large scale in all branches of the national industry, and rates of implementation of automation are increasing from year to year. Utilization of this

experience, with allowances made for local conditions and potentialities of the economy of every country, would permit considerable saving of time and manpower used at present for research of problems which are already successfully solved in the Soviet Union. It would also make it possible to prepare for broad and rapid implementation of automation in the future with a more precise understanding of potential possibilities and ways in the development of automation, as well as the solution of technical, economic, organizational, manpower training, and other problems which must be solved in connection with the introduction of automation.

Automation of industrial processes offers mankind tremendous opportunities and signifies a new and qualitatively higher stage in the history of industrial development. Socialist countries have everything necessary for taking full advantage of all these opportunities and utilizing them, in terms of history, in a very short time. They can firmly occupy the leading position in the front line of the new technological revolution and create an incomparably higher productivity of labor than was ever achieved by capitalism in the most advanced capitalist countries. Even though it will involve overcoming numerous difficulties and solving many complicated problems, there is no doubt that with the close cooperation between countries of the socialist camp the task of rapid introduction of automation in every branch of economy of the world socialist system will be successfully accomplished.

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